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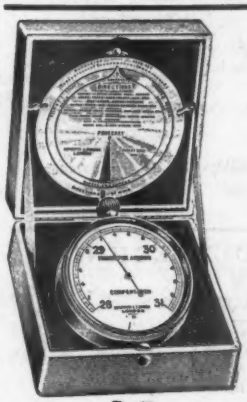

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INDIAN FOREST SERVICE.

THE SECRETARY OF STATE FOR INDIA proposes to select this summer about forty candidates as PROBATIONERS for the above service. Applications, which will be received up to July 1, 1920, must be on a printed form to be obtained from the REVENUE SECRETARY, India Office, London, S.W. 1. Probationers will be recruited under both "Ordinary" and "Special" regulations. The latter apply only to candidates who have served with His Majesty's Forces during the war for one year at least. Such candidates must have been born between July 2, 1893, and July 1, 1901, and must have received a good general education such as would ordinarily enable them to pursue a course of study at a University and obtain a degree. Preference will be given to those with some University training in natural science or forestry. Candidates under the "Ordinary" regulations must have been between 19 and 22 years of age on January 1, 1920, and must have obtained a degree with honours in some branch of natural science. The period of probation, which will be spent at Cambridge, Edinburgh, or at Oxford University, is normally two years, during which the probationer receives an allowance of £200 a year. All particulars can be obtained from the above address.

INDIAN GEOLOGICAL SURVEY DEPARTMENT.

The Secretary of State for India proposes to make four appointments to the Indian Geological Survey Department in August this year, if so many qualified candidates are available. Preference will be given to candidates who have served in His Majesty's Forces during the war. Besides a good general education, a sound education in geology is essential: a University degree and a knowledge of French or German will be regarded as important qualifications. Candidates should not be more than 25 years of age, but this rule may be relaxed in exceptional cases. Detailed regulations and forms of application may be obtained from the REVENUE SECRETARY, India Office, London, S.W. 1. Applications for appointment must be received not later than August 1, 1920.

UNIVERSITY OF LONDON.

UNIVERSITY CHAIR OF PHYSIOLOGY tenable at King's College for Women Household and Social Science Department. Salary £800 a year. Applications (12 copies) must be received not later than first post on June 30, 1920, by the ACADEMIC REGISTRAR, University of London, South Kensington, S.W. 7, from whom further particulars may be obtained.

THURSDAY, JUNE 10, 1920.

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Naval Education.

THE discussion in the House of Commons on May 17 on the vote for educational services in the Navy Estimates raised several points of interest. We note a general wish to open more widely the door from the lower deck to the commissioned ranks. At present the most promising of the younger seamen can rise, through the intermediate rank of mate, to that of lieutenant at an age which does not shut them out from further promotion. Several members expressed a hope that it might be possible to promote ships' boys to the rank of midshipman. The First Lord is reported in the *Times* to have replied that the Admiralty "could do no more than place at the disposal of these lads the very excellent educational facilities now open to the lower deck, but would approach the question with a steadfast determination to remove every possible obstacle which appeared likely to prevent these lads attaining their object."

Lieutenants whose training at Dartmouth was curtailed during the war are now sent to Cambridge for a supplementary course. The special situation which led to this arrangement will pass away, but it is intended to make the Cambridge course a permanent feature of the education of 25 per cent. of the officers, if accommodation at the colleges permits. The young naval officer sees little outside his sea life—a life astonishingly wide in some ways, and equally narrow in others—and intercourse at Cambridge with other young men will broaden his ideas.

Osborne is to be closed in May, 1921. Cadets will go straight to Dartmouth at the age of thirteen and a half and stay there until the age of seventeen; then to sea. The First Lord spoke with regret of the necessity of closing Osborne, which has done good work in education; but the total number of cadets under training on shore will be not more than 440, as against 1000 before the war, and it would be incompatible with economy to retain a special college for the younger cadets with these reduced numbers. If one of the colleges is to go, clearly it must be Osborne, where the buildings are for the most part temporary structures, whereas Dartmouth is a sumptuous edifice of brick and stone, which will house the whole number.

In an explanatory memorandum issued with the Estimates it was stated that changes were to be made in the curriculum. These are of some importance, and cannot be properly appreciated without some knowledge of the history of the matter. Lord Selborne's scheme of training (1903) provided for the common entry of executive and engineer officers; all were to enter Osborne together, and to receive an identical training between the ages of thirteen and twenty-two. Having reached the rank of lieutenant at twenty-two, they were to select the branch to which they would afterwards devote themselves—gunnery, torpedo, navigation, engineering, or non-specialist. The most difficult problem was the training of the engineer. Up to twenty-two he would not have a more intensive engineering training than all other officers; from twenty-two he would devote himself entirely to engineering. Many consequences followed this decision; in particular, it was necessary to assign one-third or one-fourth of the instructional time from thirteen to twenty-two to engineering. The engineer officers (Lieutenants E) trained under these conditions are understood to be doing well, but the time left for general education at the colleges was restricted rather severely, and in the case of the executive officers this restriction seemed to be a mistake. How could this defect be remedied without impairing the technical training of the engineers? It emerges from the Admiralty memorandum that the following solution is to be tried. The engineering time at the colleges (thirteen and a half to seventeen) is to be greatly reduced, and the time saved to be spent in enriching the cadets' literary education. At the same time, the age of specialisation for engineers is to be lowered from twenty-two to eighteen.

It may be surmised that this increased sense of the value of early general education is not unconnected with comparisons made during the war between the midshipmen from Dartmouth and the "direct entry" midshipmen who entered from the ordinary schools of the country at

eighteen. The latter are understood to have justified their selection, and in the opinion of some officers were superior to the Dartmouth entry in certain respects. One reason for such a superiority, if it really exists, is so dominant that it is unnecessary to look further. The "direct entry" midshipmen finished their education uninterruptedly at the schools, carrying it on to the age of seventeen and a half or eighteen. The Dartmouth boys were sent to sea prematurely, many of them at fifteen and a half instead of at the normal age of seventeen. They were an unfinished product, and from an educational point of view it is satisfactory that this curtailment of general education should have had such a marked effect on efficiency at sea that many officers were led to make the comparison referred to above. For the reason stated, the comparison could not be fair, but it was made, and it set naval officers thinking.

Not so many years ago it was axiomatic in the Navy that sailors "must be caught young," at a tender age, and not when they leave a public school. It is no longer axiomatic. There is acute division of opinion among naval officers on this subject. So long as it was considered necessary that cadets of thirteen and upwards should spend one-quarter of their time in engineering, it was impossible to look to the schools of the country for the secondary education of naval officers. But the amount of engineering to be learnt in future between thirteen and eighteen is not more than could be taught at any well-equipped school. The problem is therefore open whether the Navy is to continue to undertake the secondary education of its officers, or to leave the task to the schools. The First Lord stated that the Admiralty had no intention of abolishing Dartmouth as well as Osborne, and referred to advantages which could be conferred at a naval college on the sons of needy naval officers. But he believed the public-school system of entry—the "direct entry" system—to be thoroughly good, and fifteen midshipmen are to be entered annually from the schools, as against 120 through Dartmouth.

In favour of maintaining a naval college for cadets is urged the advantage of early acquaintance with Navy habits and discipline, the doubt whether the numbers required—very moderate numbers now—could be recruited at the age of eighteen, the present overcrowded state of the public schools, and the special consideration referred to by Mr. Long in his speech. In favour of relying entirely on the schools of the country, many naval officers argue that a boy's outlook is narrowed by association from so early an age with none but those of his own profession; that there is nothing at a naval college which quite makes up for the influence exerted by a good public-school house master; that "direct entry" saves heavy expense to the Exchequer; and that it is more difficult to select at the age of thirteen than at eighteen.

The debate, therefore, has begun, and the outcome will probably be determined by the eventual balance of opinion within the Service.

The Ultimate Data of Physics.

An Enquiry concerning the Principles of Natural Knowledge. By Prof. A. N. Whitehead. Pp. xii + 200. (Cambridge: At the University Press, 1919.) Price 12*s.* 6*d.* net.

PHYSICISTS and philosophers can unite unreservedly in an expression of gratitude to the author of this most acute and original work. At the present time, when it is generally recognised that the ultimate concepts of physics require reinterpretation, it is a piece of great good fortune that the task should be undertaken by a thinker who is not only one of the foremost of living mathematicians, but also a metaphysician who sees clearly the wider issues that are involved.

As Prof. Whitehead remarks, the incoherent character of the traditional concepts of speculative physics has long been a commonplace in philosophical treatments of the subject. Instantaneous moments, geometrical points, unextended particles, etc.—these may be convenient, and even essential, notions for the purposes of physical investigation, but, if taken to indicate existent entities, are quite unworkable notions. On such a basis the fact, for example, of change in all its forms would become not merely incomprehensible, but contradictory; to be intelligible, "change must," as Lotze put it, "find its way into the inside of being." In other words, change as mere sequence, as mere alternation, is an impossible thought. Change means, if it means anything, continuous modification in that which preserves a certain identity or unity, without, however, implying that the latter ingredient is something separate from the former. Nothing which is characteristic of force, velocity, energy, and life can exhibit itself at a durationless instant. The slightest functioning of a living organism obviously takes time, but so also does that of a molecule of iron. In Aristotelian language, it may be asserted that the true nature of any real existent

is never that which can be present all at once, but that which is being realised in the totality of phases through which the existent thing in question passes.

Since the appearance of his well-known paper in the *Phil. Trans.* of 1906, Prof. Whitehead has been wrestling with the problem which considerations such as these occasion, and he has now worked out a positive theory of the structure and diversification of Nature, upon the basis of which a rationale can be furnished of the concepts indispensable in mathematical physics. The aim, then, of the present volume may be said to be twofold: (1) To determine by analysis of what is offered in perceptual experience the ultimate data of science and their relations; and (2) to show how the concepts of mathematical physics and their relations can be exhibited as functions of the former.

Nature, so I understand Prof. Whitehead to mean, must be regarded as in its totality a continuous stream of process, of becoming, of creative advance. Within this whole there call to be distinguished two essentially different, yet intimately connected, types of entity—events and objects. Employing, again, Aristotelian phraseology (and in many ways Prof. Whitehead's scheme of Nature more nearly resembles the Aristotelian scheme than any other), events constitute the ὕλη and objects the εἶδος of things. Events are either durations or bits of a duration, and a "duration" is a "slab of Nature," limited temporally, but unlimited spatially, which is contemporaneous with the specious present of any percipient. The fundamental relation of events is that of extending over each other, and this relation of "extending over" is the common root from which both temporal extension and spatial extension take their origin. Strictly speaking, events themselves do not change; they pass into other events, and in passing become parts of larger events, the passage of events being extension in the making. Moreover, some of the events that are parts of durations (*e.g.* a specific state of perceiving) have a relation of cogredience to a certain duration—that is to say, they are temporally coextensive with it, and they occupy in it a fixed spatial position. Furthermore, events are the "situations" of objects—an object is located in an event as that event's characteristic or quality. Like Aristotle's εἶδος, an object is permanent. When we speak of its change we really mean its diverse relationships to diverse events. Precisely the same object can characterise two or more events. The continuity of Nature is to be found in events. The atomic properties of Nature reside in objects. There is, in short, a structure of events (an "ether of events" rather than a material ether), and it provides the framework of the externality of Nature within which objects have their subsistence. This structure is capable of being analysed in a number of different ways, and by adopting different modes of analysis we human beings can get at the various kinds of events which are "situations" of different types of objects. The more important of these types are: (*a*) Sense-objects—*e.g.* definite sense-data; (*b*) perceptual objects—*i.e.* the so-called "things" of ordinary experience; and (*c*) scientific objects—*i.e.* the characteristics (electrons, etc.) of events as active conditions. With the exception of those perceptual objects that are delusive, all these types of objects are equally real. Their *esse* is neither *percipi* nor *intellegi*.

For the mathematician the detailed working out of the way in which the concepts of point, instant, particle, etc., may be brought into connection with the data just indicated will probably be the most valuable part of the treatise; but I must be content to record that it is accomplished through persistent applications of what is named the method of extensive abstraction. This method, it is explained, is that which in its own sphere (the sphere, namely, of geometry and mechanics) follows the procedure of the differential calculus in the region of numerical calculation. It converts a process of approximation into an instrument of exact thought. By its means, as Dr. Broad has neatly expressed it, the *convenience* in these concepts is retained, while the *fiction* in them is eliminated.

With the main principles of Prof. Whitehead's philosophy, yielding, as they do, a view of Nature strikingly antithetical to that of the logical atomism developed by Mr. Russell, the present reviewer is in close agreement. One would like to press, indeed, for a fuller elaboration of the notions of "duration," "event," and "passage of events" than is here attempted. For one has an uneasy feeling that a host of embarrassing problems lies concealed in those notions. And then, again, one is uncertain about the mode in which events are supposed to be apprehended. While objects are recognised, events, we are told, are "lived through," by which apparently we are to understand that not only the "percipient event" (*i.e.* the actual phase of experiencing), but also the whole duration with which it is cogredient is "lived through." Yet obviously it is not meant that the countless other events, some cogredient and others not with that duration, are in like manner "lived through," and one fails to see how there can be any unique process of appre-

hending *them*. Once more, one would be prepared to question whether "sense-objects" are primary as compared with "perceptual objects"—primary, that is, in the sense that the recognition of them is precedent to the recognition of the latter. But the last two of these criticisms turn upon matters of detail, and the first amounts to a large order. When all this is said, the fact remains that in the volume before us we have a really great effort of constructive thinking. Prof. Whitehead modestly observes that his book "raises more difficulties than it professes to settle." He adds, however, with true insight, that "to settle the right sort of difficulties and to raise the right sort of ulterior questions" is to accomplish one step further into Nature's background of mystery.

G. DAWES HICKS.

Life and Letters of Silvanus P. Thompson.

Silvanus Phillips Thompson, D.Sc., LL.D., F.R.S. His Life and Letters. By J. S. and H. G. Thompson. Pp. ix+372. (London: T. Fisher Unwin, Ltd., 1920.) Price 1*l.* 1*s.* net.

IF this biography of the late Silvanus P. Thompson, written by his wife and daughter, is perhaps a little wanting in the detached criticism that could have come only from someone outside the family circle, it gives, from an inside and intimate point of view, a good idea of the extent to which its subject appreciated the gospel of work, and how he applied himself, with all his might, to the many varied and interesting things that he found for his hand to do.

The book commences with some account of Thompson's Quaker ancestry and his early training at Bootham School, York, and at the Quaker Training College at Pontefract. Later, Thompson returned to Bootham School as a junior master, and it was during this time that he made the first of many visits to the Continent, which he evidently greatly enjoyed, and which did so much both to widen his outlook and to increase the large number of his foreign scientific friends. His appointment as lecturer on physics at Bristol was the first step in his scientific career, and at Bristol he remained, lecturing to his students and also, farther afield, to various popular scientific societies, attending meetings of the British Association, and making many contributions to electrical science, until his appointment as principal of the Technical College at Finsbury, which was the chief scene of his labours for the remaining thirty-one years of his life.

Essentially fitted by Nature to be a teacher and an exponent, and endowed with habits of industry to a rare degree, Thompson touched little that he did not to some extent adorn, and while in an age of specialism, by reason, no doubt, of a certain diffuseness of his interests, he never concentrated sufficiently upon any one branch of scientific research for his name to be associated with any first-class discovery, there can be no doubt as to the considerable extent that, by his books, his lectures, and his teaching, he forwarded the progress of science, and especially of its applications, during many years of activity. We learn that with remarkable industry he was the author of no fewer than seventeen published books, besides eleven others that were privately printed, while his addresses and communications to societies during the forty years from 1876 down to the date of his death number 177. Electricity, magnetism, optics, and acoustics were his principal subjects, but he also wrote on educational, religious, and other questions, while not least amongst his writings will be considered his biographies of Kelvin and of Faraday, and his notes on the lives of Peter Peregrinus, the soldier of fortune who penned his treatise on the magnet as early as the thirteenth century; Gilbert, the Elizabethan physician, who also wrote on the magnet; Sturgeon, the inventor of the electro-magnet; and Phillip Reis, whose apparatus, if it was not sufficiently developed to become of practical utility, was, at any rate, the forerunner of that wonderful instrument of sublime simplicity, the speaking telephone of Alexander Graham Bell.

Thompson, too, at an early stage in his career, tried his hand at practical telephonic invention, but his ingenious valve telephone was held by the courts to be an infringement of the Bell-Edison patents, and its sale was prohibited. Only on one other occasion do we find him coming out as an inventor, this time in connection with submarine cables for telephonic and high-speed telegraphic purposes. Here, though his particular arrangement of inductive leaks never came into practical use, it led the way to the Pupin loading coil, with which much has been accomplished.

It is recorded that, as a young man, Thompson cared little for games; but that this did not mean any lack of appreciation of the lighter aspects of life is evidenced by the vein of humour in many of his letters, and by the prominent part he took in connection with the "Red Lion" dinners of the British Association, and with such clubs as the Gilbert Club and the Sette of Odd Volumes, in which latter he bore the appellation of Brother Magnetizer. He also had many hobbies, some of which were not scientific, as, for instance, music, poetry, and painting, while as an artist himself he held no mean place, and occasionally exhibited

at the Royal Academy. An exhibition of his sketches held after his death comprised more than a hundred separate pictures.

Himself probably the most eloquent of scientific exponents since Tyndall, it is interesting to learn that Thompson fully realised, as has many another, the difficulties pertaining to the giving of a Royal Institution discourse, where it is not unusual for some few of the audience to know quite as much as, if not more than, the lecturer, while the majority can fully understand but little of what they hear. Of interest also is the account of the slender beginnings of his library, which his proclivities as a collector and as a learned bibliophile led him to accumulate, until, enriched as it was by many ancient works and a whole host of rare pamphlets, it developed into one of the most complete and valuable existing collections of electrical publications.

It is satisfactory to know that the skill and labour expended in making this collection will not be thrown away, as the whole library is to be preserved intact at the Institution of Electrical Engineers, where it will form a worthy monument to Thompson's industry and discernment.

A. A. CAMPBELL SWINTON.

Academic Research and Industrial Application.

The Chemistry and Technology of the Diazo-Compounds. By Dr. J. C. Cain. Second edition. Pp. xii + 199. (London: E. Arnold, 1920.) Price 12*s.* 6*d.* net.

THE important chapter in organic chemistry which is summarised so admirably by the author of the treatise under review affords a striking illustration of the difficulty of explaining the details of a chemical synthesis to a non-chemical, although scientific, audience.

The element carbon furnishes the framework or skeleton of all organic compounds, but much of the chemical liveliness appertaining to the more reactive of these substances is due to nitrogen, an element endowed with a dual personality. In the free state inert and loath to enter into chemical combination, when combined it becomes extremely active. Everything living that grows contains nitrogen, and this element is also present in all organic explosives and in the physiologically active alkaloids. It is, therefore, not surprising that the study of organic nitrogenous substances has always had a great fascination for chemists, who have never grown tired of speculating on the molecular structure of these compounds. It was from this academic point of view that about sixty years ago Prof. Kolbe, of Marburg, set his pupils to work on the action of nitrous acid on various aromatic amines, nitrogenous compounds of the ammonia type derived from the aromatic hydrocarbon, benzene. One of these workers was Johann Peter Griess, who, on treating picramic acid with nitrous acid, discovered the first diazo-compound, so called because its molecule contained a very reactive group, N_2, consisting of two atoms of nitrogen or azote.

Purely as a matter of scientific curiosity and without any thought of possible applications, Griess proceeded to generalise this reaction and succeeded in showing that the common primary aromatic amines yielded diazo-compounds. These diazo-derivatives, he found, were very reactive compounds, and he tried their action on all possible substances. He was thus led to make a discovery of the utmost technical importance, namely, the synthesis of the azo-colouring matters. The diazo-reaction itself was discovered in 1858, and Griess obtained the first azo-colour in the years 1861–62. This dye was first manufactured in 1865 by Caro, a German chemist then employed by Messrs. Roberts, Dale, and Co., of Manchester. The greater part of Griess's work was carried out in England, first in London in Hofmann's laboratory, and afterwards while engaged with Messrs. Allsopp, of Burton-on-Trent.

From those early days to the present time the diazo-reaction has gone on becoming increasingly useful both in technical and in academic chemistry. The azo-colours produced a revolution in the art of dyeing because a large and important group was found to have the valuable property of dyeing cotton directly without the intervention of a mordant. Other azo-dyes have found useful application as extremely fast mordant dyes on wool. A third group, the azo-pigments or ingrain dyes, are formed within the textile fibre by impregnating this material successively with the components of the azo-coupling. All students of organic chemistry are familiar with the Sandmeyer and Gattermann reactions, by means of which diazo-compounds become synthetic agents useful in elucidating the constitution of aromatic or benzenoid derivatives. The diazo-reaction has been of service in the production of synthetic drugs, notably those of the salvarsan group. It was employed during the war in the manufacture of sternutatory materials for chemical warfare. These synthetic developments are all duly noted in Dr. Cain's treatise, which includes many references to original literature. To the student of historical chemistry not the least interesting chapters will be those on the theories of the constitution of diazo-compounds. This discussion

deals fully with the celebrated Hantzsch-Bamberger controversy, which was maintained for several years. The author has himself formulated a theory of the constitution of diazonium salts which, with a modification suggested by the reviewer, is sufficiently elastic to account for the properties of aromatic diazo-compounds and also for the existence of a rapidly increasing group of heterocyclic and non-aromatic diazo-derivatives. A new chapter on the latter group has been added to this second edition of a unique monograph.

G. T. M.

Ancestral Studies of Compositæ.

The Origin and Development of the Compositae: Thesis approved for the Degree of Doctor of Science in the University of London. By Dr. James Small. (*New Phytologist* Reprint, No. 11.) Pp. xi+334+6 plates. (London: William Wesley and Son, 1919.) Price 15*s.* net.

THERE is perhaps a tendency among systematic botanists to fight shy of the Compositæ, on account largely of the enormous size of the family and the difficulties of properly classifying its members. Those, however, who once succeed in passing these lions in the path soon become enthusiastic students of the group, and Dr. Small is no exception to this rule. His contribution to the investigation of the origin and development of the family is by far the most important that has appeared for many years.

After a general discussion of previous literature, in which the most important names are those of Cassini and Bentham, the author goes on to deal with the various morphological and ecological features of the family one by one, considering, for example, the pollen-presentation mechanism, the corolla, the pappus, the involucre, the receptacle, the phyllotaxis, and the fruit dispersal From all of these, similar general conclusions are drawn, to the effect that the Senecioneæ are the most primitive type of the family, and that from them, directly or indirectly, and ultimately from Senecio itself, as the basal genus from which the Senecioneæ arose, there sprang all the other tribes and genera of the family. This is then very strikingly confirmed by a study of the geographical distribution, which shows what would be expected upon this theory of mutational origin, and upon the hypothesis of age and area, which is likewise adopted. It is shown that the distribution of Senecio (the oldest genus) is the widest of all, and that of other tribes and genera less and less in proportion to their lesser age.

Senecio is supposed (and the evidence is fairly clear) to have arisen from the Siphocampylus group of Lobelioideæ, and probably in the Bolivian highlands after the upheaval in the Cretaceous period had provided available land above the limit of trees. Once formed, its pappus fruit and the great area of open land available in the mountain chains which with few breaks run all round the world enabled it to spread rapidly over America, Asia, Africa, and Europe.

In the final chapter an interesting sketch is given of an hypothetical evolution of the Compositæ from Senecio, based upon the various conclusions drawn in the course of the work, summed up largely in a diagram on p. 297, which illustrates this evolution in time and space. The second great genus to evolve is supposed to have been Gnaphalium (from which the Inuleæ are descended), then Spilanthes (Heliantheæ), Solidago (Eupatorieæ and Astereæ), and so on. The whole is a striking and interesting illustration of the way in which our whole outlook upon phylogeny has been altered by the acceptance of the modern theories of evolution and geographical distribution.

In the course of the work many minor points are further elucidated, such as irritability in the pollen-presentation mechanism. Good reasons are brought forward for supposing the pappus to be of trichome nature, and by an ingenious mechanism the dispersal of the seed was studied, and it was shown that a very slight wind was sufficient to keep the seeds aloft in sufficiently dry air, so that there is no need for land bridges to explain the distribution. Many other points are also dealt with, for which reference must be made to the original.

Our Bookshelf.

Monarch: The Big Bear of Tallac. By Ernest Thompson Seton. Pp. 215. (London: Constable and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

THIS is a composite picture of a grizzly bear, or, more exactly, the personality of one remarkable bear still living in prison has been credited with the adventures of several of his kind. Beginning with the growth and education of the cub, the book tells the story of many ups and downs, such as the first sheep-stealing, the escape from the forest fire, the circumvention of the hunters; the affair of the ten-gallon empty sugar-keg with the delicious smell, into which the bear thrust his head; and the final capture (by means of drugged honey) of an adventurer with many aliases. Mr. Thompson Seton is a fine raconteur, but we wish he had put a little more stuffing into the book; and his literary facility sometimes gets

the better of his judgment. "And still he lives, but pacing—pacing—pacing—you may see him, scanning not the crowds, but something beyond the crowds, breaking down at times into petulant rages, but recovering anon his ponderous dignity, looking—waiting—watching—held ever by that Hope, that unknown Hope, that came." Throughout the book we get glimpses of a river that does not reach the sea, and a poetic parallelism is sustained between river and bear—both ending in imprisonment. "The river, born in high Sierra's flank, that lived and rolled and grew, through mountain pines, o'erleaping man-made barriers, then to reach with growing power the plains and bring its mighty flood at last to the Bay of Bays, a prisoner there to lie, the prisoner of the Golden Gate, seeking forever Freedom's Blue, seeking and raging—raging and seeking—back and forth, forever—in vain." So with the bear. The book is delightfully printed and got up, and many of the thumb-nail drawings are very graphic. We are told on what pages they occur and on what pages the chapters begin and end, but there is no pagination!

Religion and Culture: A Critical Survey of Methods of Approach to Religious Phenomena. By Dr. Frederick Schleiter. Pp. x+206. (New York: Columbia University Press; London: Humphrey Milford, 1919.) Price 8*s.* 6*d.* net.

IT is well to be reminded by such an acute critic as Dr. Schleiter that anthropology, one of the youngest of the sciences, is still in search of the one scientific method of analysing and co-ordinating the enormous mass of material which has been, and is still being, collected. The object of this book is to review the methods in use at present and to point out certain difficulties which each involves. Though in his preface the author tells us that he has in some degree modified his iconoclastic attitude towards the comparative method, his criticism still remains sufficiently drastic. Thus he remarks that "in his immensely voluminous works" Sir James Frazer has embodied "several mutually irreconcilable types of research." Again, the method of intensive study of a limited group of cultural facts—the Australian culture, for instance—"bristles with fallacies and insupportable pre-suppositions." In dealing with Mana, Dr. Marett "appears to have expressed bewildering varieties of opinion on this subject." Sir E. Tylor postulates "a single coherent and systematic view of the world, or what he repeatedly refers to as a 'philosophy of nature.'" But "all ethnological evidence tends to show that no such universal systematisation of experiences has ever taken place." In short, "ethnographical literature, as a whole, presents to us little more than groups of classifications carried out from mutually irreconcilable points of view—the advocates of the separate principles being gathered into schools which profoundly distrust each other's results."

Dr. Schleiter, though an acute critic, is not a lucid writer, and his work is critical rather than constructive. He supplies a bibliography, but, strange to say, no index. We can do no more at present than indicate the scope of this important review of methodology applied to ethnography.

Manuel Pratique de Météorologie. By J. Rouch. Pp. viii+145+xiv plates. (Paris: Masson et Cie, 1919.) Price 6.50 francs net.

THIS book, the outcome of war experience especially with aviators, is designed to give those who receive weather forecasts some knowledge of the principles on which they are based. The greatest measure of success is likely if the recipients have this knowledge, and are also in personal contact with the forecaster.

The construction of weather charts, the interpretation of their broader features, and the travel of large weather systems are dealt with in the first eight chapters. The greatest danger, however, often attends the passage of smaller travelling systems. Accordingly, chap. ix. discusses in great detail secondary phenomena, line squalls, thunderstorms, etc. Fog has a separate chapter, and an account is given of the main results of recent upper-air research. A useful feature is a list of the chief barometric situations of the year 1917 to serve as examples supplementary to those given in the book. The published daily charts of the Bureau Central Météorologique may be obtained for this purpose.

Detail is not lacking, and physical explanations are given of many phenomena. The book should appeal to meteorologists, as well as to "those who, without being meteorologists, wish to know what the weather will do." M. A. G.

Wireless Transmission of Photographs. By Marcus J. Martin. Second edition, revised and enlarged. Pp. xv+143. (London: The Wireless Press, Ltd., 1919.) Price 5*s.*

A CERTAIN amount of experimenting has been done from time to time on the transmission of sketches, photographs, etc., electrically along ordinary telegraph circuits, but in the case of long lines success has been limited by the difficulty of obtaining sufficiently sharp current impulses owing to the capacity effects in the line. This difficulty disappears with wireless transmission, and it is chiefly for this reason that the author anticipates greater success, as well as greater convenience, in the apparently more delicate methods which it is his purpose to describe. In his own system a bichromate print made on a metal film is rotated on a drum at the same time fed axially, and a stylus is caused by the presence of the picture to make intermittent contact and to send a series of impulses from an ordinary wireless transmitting set. A synchronised drum at the receiving end carries a photographic film, and a beam is directed on to it, which is made intermittent by the movement of a small shutter controlled by the receiving apparatus. Considerable ingenuity has been exerted to overcome the many practical difficulties encountered. The additions to this the second edition relate chiefly to optical and photographical matters.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Organisation of Scientific Work in India.

As NATURE waited for more than a year to criticise the Indian Industrial Commission's Report which was published in October, 1918, it will probably tolerate this additional delay of a few weeks (due to my absence in India) in attempting, on behalf of my colleagues, to demonstrate that the impressions conveyed by the leading article in the issue of February 19, and by the letters which followed in three later issues, bear little resemblance to the Commission's proposals for "the organisation of scientific work in India."

We are well aware out here that the writer of the article borrowed many of his expressions, and that the correspondents who furnished the subsequent applause obtained their impressions of the Industrial Commission's scheme from a memorandum which was privately composed and circulated among a few scientific men in England after the departure of the only two members of the Commission who were at home last year on leave. If I had seen the private memorandum only, I, too, should have added my vote to the others in condemning a scheme apparently designed to tamper with the form of liberty that is essential to scientific research; and I doubt if I should have shown the canny wisdom of a distinguished chemist who, in reply to the author of the memorandum, cautiously commented on "proposals *said to have been* set forth in the report of the Indian Industrial Commission." That most of your distinguished correspondents had not read the Commission's report itself is obvious enough from their letters, though only one of them frankly says so. One writer, for example, states that "under the centralisation scheme the work of an investigator would depend on the previous sanction of the head of the Service, who would probably not be of any scientific eminence, or might even be without scientific qualification." The one obvious and plainly stated object of the Commission's scheme is to release isolated scientific research workers from control by non-scientific officials, and it is so designed that even the scientific officer suggested for the head of each Service cannot do more than criticise and advise without interfering.

According to the privately circulated memorandum, "two policies are at present in the field: (*a*) absolute centralisation with the formation of distinct, water-tight, graded departments of science (botany, zoology, chemistry, etc.) being controlled by a separate departmental head." This is intended to represent the policy of the Industrial Commission, and the literal agreement between the statement in the leading article of February 19 and three-quarters of this quotation is as important to notice as the additions made by the writer of the article. Both, like your correspondents, have confused the wholly distinct terms "services" and "departments," which are clearly distinguished in the Commission's report; but the writer of the article has also gratuitously added a statement which neither the Industrial Commission nor any other responsible body here has ever suggested, namely, the placing of "botanists, zoologists, and so on," under the proposed Imperial Department of Industries.

Your correspondents, out of the fullness of their successful experience, reproduce many well-worn platitudes on the freedom necessary for research, but they overlook the fact that many young scientific officers are employed for such accessory routine duties as analyses and identifications, which may be dull, but are essential to the operations of agriculture, forestry, and mineral development. They forget, too, that most of the so-called research work of many others is purely descriptive, which is equally essential in a country stocked with raw materials of unknown nature. Unless their work comes to the notice of a senior authority of their own caste, young scientific officers so employed in departments or institutions controlled by non-scientific officials would rarely get a chance of showing their worth or of justifying their desire for research opportunities; unless they are members of some "service," and thus come automatically to the notice of their scientific chief, they must either remain low-paid "hewers of wood" or refuse to renew their agreements and quit.

Then among those who already enjoy opportunities for research there are some who need the support of an independent senior authority in their desire to obtain the necessary freedom and funds from the local authorities in control; and it matters little whether the "constituted authority" be a committee, a board, a hidebound official, or our most senior of scientific councils, which Prof. Soddy regards as the obsolete product of inbreeding, for all have learnt the danger of taking unchecked the average man's estimate of his own worth. There are some, too, among our isolated scientific workers who have not sufficient confidence in themselves to close their inquiries for publication; they need the crystallising influence of a senior worker who has the right to ask them how they are getting on with that piece of research which was in progress last year; there are others who, distracted by the abundance of their ideas and the wealth of available raw material, pass from one inquiry to another without finishing any; there are some who, in their isolation, unwittingly waste time in pursuing lines already more completely developed but not yet published elsewhere. Then there are isolated workers who, for want of a pace-maker, grow weary in well-doing; and, finally, there is the inevitable residue who, through uncontrolled freedom, become charlatans. But although all these well-known species of scientific men are represented in India, I doubt if we have any here who have yet attained such experience and dexterity in the use of "scientific method" as to justify their criticising a report that they have never seen.

Your leading article of February 19, after referring to the research work done in existing institutions of various sorts, asserts that "the present system has proved successful in practice." It would not be fair, nor would you find space, to describe the painfully numerous exceptions; but if the situation must be summed up in only a few words, the following two statements are sufficient: (1) During its tours the Industrial Commission received complaints nearly everywhere of the disabilities that handicap scientific workers under the present "system"; and (2) the most conspicuous success is also the most centralised institution of all, namely, the Geological Survey, which is a Department as well as a Service.

We cannot hope to provide for other scientific workers the amenities now secured by the geologist; he inherits the results of the forethought of a distinguished scientific worker who had also a genius for administration—Dr. Thomas Oldham. But it was the hope of the Industrial Commission to devise a scheme which (taking into account established vested interests, the tendency towards provincial autonomy,

and the transfer of some provincial scientific institutions to the control of popular representatives necessarily anxious for visible results) would retain for scientific workers the security of a central Service, and, so far as their research activities are concerned, the advantages of the support and criticism of a senior officer of their own caste. Our scheme is not an attempt to impose arbitrary control, but a simple response to a general petition from scientific workers for protection and support.

It cannot be applied, however, without suitable modification to fit established interests and institutions. There are, for example, forest botanists who are forest officers first and botanists after; their bond with the Forest Service is closer than with the Botanical Survey, and both should be developed as complementary, not competing, Services. There are agricultural chemists whose community of interests with the rest of the Agricultural Service forms a stronger service link than their affinities to other chemists; they might more appropriately be termed chemical agriculturists, and, having one of their own, they need not form part of the suggested Chemical Service.

To find out whether the general principles suggested by the Commission are applicable at all to each of the major sciences, and, if so, to adjust the scheme to established conditions, requires examination by special committees. One such committee for chemistry under Prof. J. F. Thorpe has just published its report, from which it will be seen that a committee composed of six chemists and one administrative officer, after examination of witnesses and institutions in various parts of India, accepts for chemists the scheme which your correspondents, rashly believing a privately concocted memorandum, label as "servitude undisguised," a "means of encouraging mediocrity," "bureaucratic centralisation," and other epithets.

To those of your readers who do not know the motive of the private memorandum referred to above, the special reasons for delaying the date for its distribution to every member of the Royal Society's Indian Advisory Committee—except myself, its chairman—and the selection of "the solid ground of NATURE" as the *point d'appui*, this "mass attack" on the Industrial Commission's scheme has doubtless all the appearance of spontaneity and honest conviction.

By an official accident, not foreseen by the author of the private memorandum, I have now before me (1) a proposal from a committee of botanists for the enlargement of the Botanical Survey, and (2) the unsought advice of a forest botanist who, through commendable but over-jealous regard for his own institution, submits opinions collected from ingenuous scientific men and the correspondence in NATURE in support of his proposal, not for the expansion, but for the limitation of the Botanical Survey to one cryptogamic botanist and three specialists in medicinal plants. And this in a tropical and semi-tropical country covering 1,750,000 square miles! Fortunately, there is enough evidence available to justify further support for, and the independent maintenance of, both botanical institutions: but the petty jealousies of those who suffer from this form of mental astigmatism scarcely reinforce one's efforts to secure for isolated unorganised workers in other sciences the benefits now enjoyed by the geologist, or to secure for all scientific workers in India the privileges and recognition long ago accorded to engineers, doctors, and the members of the Indian Civil Service.

THOMAS H. HOLLAND,
President, Indian Industrial Commission.

Simla, May 5.

[The leading article to which Sir Thomas Holland refers described the proposals of the Indian Industrial Commission and discussed the policy of centralisation and the creation of graded scientific Services in comparison with the present system under which research is carried on in India. In the correspondence which followed attention was given chiefly to the general principles of "Organisation of Scientific Work," and it was not necessary to be familiar with the Report of the Commission in order to express opinions upon these, or to urge that creative investigators produce their best results when they are given perfect freedom of action. The proposed scientific Services of India may, as regards their aims, be compared with the Industrial Research Associations at home, and are similarly capable of promoting progress in both pure and applied science. But the work carried on at universities and research institutes by men outside official Services has even greater need of financial support, because its value is not so readily understood. This is the aspect of productive research with which we are particularly concerned, and for which we ask full consideration.—ED. NATURE.]

Anti-Gas Fans.

I HAVE read Mrs. Ayrton's letter in NATURE of June 3, after, unfortunately, missing the note in the issue of May 13, as well as the *Times* correspondence referred to. I have no intention of entering into a controversy, polemical or otherwise, with Mrs. Ayrton, but should like to put my views before your readers, as I believe them to be shared generally not only by Headquarters Gas Service officers, but also by regimental soldiers of all ranks, including Gas *personnel*.

The crux of the matter is this: The problems involved in gas defence after July, 1917, when the enemy commenced using "mustard gas," were of a totally different nature from those which had to be faced before that date. Then, apart from small quantities of the annoying, but otherwise practically innocuous, "tear gas," we had to deal with moderate quantities of lethal gas shell, containing the *volatile* "diphosgene," and, very occasionally, with waves of cloud gas. Under those conditions the gas, except in very cold weather, disappeared quickly (a matter of minutes) from the open, or even from trenches of average depth, but was liable to collect and remain in shelters for hours, or even days. When such shelters had been once cleared they were habitable, as no "gas" remained outside in the neighbourhood to contaminate them further. For this purpose the Ayrton fan was found to be useful, and large numbers were issued as trench stores. Later the more simple, and quite as efficacious, method was introduced of merely lighting a small fire in the shelter, and thus causing a through draught. This was found to be distinctly superior for deep shelters, such as those in the chalk country of the Somme battlefield, and, moreover, was far less fatiguing to the men employed. Working an Ayrton fan, even in the most approved fashion, when wearing a gas-mask on a hot day, is a tiring task.

After the date mentioned we had essentially to deal with a relatively *non-volatile* shell-filling, which produced its well-known effects at concentrations far below those at which the volatile fillings became innocuous, and was used by the enemy in very large quantities. This gave little warning of its presence to the uninitiated, soaked much of the ground and pervaded the whole atmosphere in the shelled area for days afterwards, made great demands on the endurance and discipline of the soldier, and called for quite new measures. This is not the place to discuss these measures, but it is clear that the use of either fire or

fan to remove gas from shelters could really be effectual only after first dealing with the area round the shelter. That is one reason for the relative decline in the fortunes of the Ayrton fan. I say *relative*, as large numbers of such fans were issued even during the winter of 1917–18, and, for all I can remember, still later. Other reasons were the natural and rooted objections of the regimental officer and soldier respectively to be responsible for, or to load himself with, stores of (to him) problematical value, and the growing favour shown to the alternative fire method. (It was said, perhaps not without malice, that Ayrton fans were often used for clearing shelters from gas—by fire!)

However that may be, there was no demand by troops for the fans towards the end of the war; on the contrary, we were besought to withdraw them. I know this myself from many personal interviews with regimental officers and from reports furnished by Gas *personnel* of every type of unit and formation. There were, of course, up to the end of the war gas casualties caused by men sleeping in shelters which might have been successfully cleared of gas either by the fan or by fire. They were, however, owing to the particular properties of "mustard gas," a small proportion of the whole; and fatigue and ignorance and the exigencies of the battle were their causes.

I must, therefore, characterise as quite unfounded the view that much suffering and loss of life could have been avoided by increasing the provision of Mrs. Ayrton's fan. Regimental and Gas Services *personnel* were both far too anxious to reduce gas casualties in every way practicable. It was ultimately the fighting soldier who decided, after weighing all the facts of the situation, that the fan, useful in sound and well-established trenches, was scarcely "worth while" during the advances and retirements of 1917–18 or in the mud and pill-boxes of the Ypres salient—this apart from the question of "mustard gas." Mrs. Ayrton is very obviously sincere, but, like another distinguished civilian who has recently written on camouflage, is not quite *au fait* with the realities of the battlefield. Exaggerated attacks of this nature on the War Office are liable to defeat their own ends, and also to neutralise the efforts of others who are trying to ensure the application of scientific methods to military problems in a more systematic manner than has been the case in the past.

A. J. ALLMAND.
(Late Chemical Adviser to Fourth and to Second Army Headquarters.)
King's College, W.C.2, June 7.

Attainment of High Levels in the Atmosphere.

I MUST confess that I am very sceptical as to a sounding balloon having reached 37,000 metres or a pilot balloon 39,000 metres, as mentioned in NATURE for June 3, p. 437, although such heights would be possible if sufficiently large balloons were employed.

A sounding balloon as commonly used is a small india-rubber balloon expanded by hydrogen to about twice its natural diameter, and then securely tied up. The rubber stretches as the balloon ascends, until finally it can stretch no further and the balloon bursts. Under the supposition that the pressure and temperature of the gas inside are the same as those of the air outside, and under average conditions of temperature for Europe, the following rules hold: The starting diameter is doubled at a little more than 16 km., trebled at a little more than 24 km., and quadrupled at 30 km. Since the starting diameter is about double the natural diameter, this means that at 30 km. the rubber has stretched eightfold linearly and its thickness been reduced sixty-fourfold. I do not think any rubber that will stand this treatment can be found.

On the other hand, a precise calculation of a great height is in practice impossible. We can only measure the pressure, and when the air pressure is greatly reduced a very small error in the pressure makes a large error in the height.

For a pilot balloon, if the balloon is near the zenith and the base line for the theodolites a long one, there is not so much risk of error; but if, as is usually the case, the balloon has drifted a long way, particularly if it has drifted in the direction towards which the base line points, then a small error in the setting of the theodolites or in reading the angles will make a great error in the height.

It is desirable that when the recorded height has reached an abnormal value the computer should give full details and state his reasons for believing it to be genuine, otherwise one is apt to think some mistake has crept in.

W. H. DINES.
Benson, Wallingford, Berks, June 4.

Central Wireless Station for Astronomy.

IN the "Astronomical Column" of NATURE of May 27 it is stated that "Prof. Kobold, editor of *Astr. Nachrichten*, and director of the Central-stelle, delegated the latter work to Prof. Strömgren, Copenhagen, during the war, but has now resumed it, and announces in *Astr. Nach.*, 5044, that arrangements have been made for the distribution of astronomical information by wireless telegraphy from the Nauen station."

It will be remembered that, in pursuance of resolutions adopted by the International Scientific Academies at London and Paris in 1918, there was established at an international conference held at Brussels in July, 1919, among other Commissions, a Commission of Astronomical Telegrams, with a central bureau at the Royal Observatory of Belgium (Uccle), to replace Kiel, for the purpose of receiving, centralising, and dispatching information concerning astronomical discoveries, observations, and calculations, either by telegram or post, to the various institutions or private persons subscribing to it.

Surely with such an organisation in full working order this Commission should undertake the dispatch by wireless of astronomical information of great urgency, such as the appearance of a new star, etc., if such information is going to be distributed by wireless at all!

Practically every observatory in Western Europe now takes in the time and weather signals from the Eiffel Tower, and any news of an astronomical nature could be easily transmitted to that station from the central bureau at Uccle (or Brussels) and re-transmitted from the Eiffel Tower at, say, 10.00h. and 16.00h., the standard times of transmission of the time and weather signals.

Before the war the Central Bureau of Astronomical Telegrams was located at Kiel, but this organisation has *ceased to exist* from an international point of view. There seems no object, therefore, in reviving it at Nauen (near Berlin) purely for the sake of this wireless astronomical information, when this mode of dispatch can be as easily adopted in Western Europe for this purpose.

Prof. Kobold seems not only to ignore the existence of the new International Central Bureau in Belgium, but also assumes that the war has made "no difference."

WILLIAM J. S. LOCKYER.
Hill Observatory, Sidmouth, S. Devon,
May 28.

The "Flight" of Flying-fish.

I HAVE on frequent occasions (in the Mediterranean, the Red Sea, and the Indian Ocean) carefully observed with a field-glass (×8) the supposed "flight" of flying-fish, and have always concluded that the "leap and glide" theory is the correct one, with one or two modifications. Dr. J. McNamara, in NATURE for June 3, p. 421, cites five facts in support of the theory of true flight, but I may point out that all these five facts can be otherwise interpreted. Flying-fish undoubtedly leap out of the water and gain their initial impetus by tail action, and when out of the water the pectoral fins serve as planes. While gliding the fish can not only renew its impetus to a limited extent by an occasional flick of its tail against the crest of a wave, but, as your correspondent says, can also change the direction of its glide. I have, however, never observed a fish "come back in a direction opposite to the direction in which it set out," and I am tolerably certain that it could not do this without re-immersion in the water, unless perhaps a strong wind were blowing in this opposite direction. Flying-fish can certainly rise and fall during the glide, but this, as well as change of direction, can be easily explained by assuming inclinations of the planes of the fins—a very different process from actual "wing"-flapping sufficient to cause flight. The fins can, like those of most fishes, move on their bases, but I fail to understand how, in the absence of the required musculature, it can possibly be supposed that the fins show "rapid movement, as in the case of hovering flies and humming-birds." If seagulls can glide for hundreds of yards, rise and fall, and change direction without wing-flapping, why not flying-fish? In gliding the outlines of the pectoral fins naturally appear to be indistinct, because, compared with the rest of the body, the fins are thin and irregular in outline on their posterior edge.

Granting that the body can gain fresh impetus by an occasional flick of the tail against a wave-crest (and this can be easily seen to occur, and is certainly less difficult to understand than the initial tail action which enables the fish not only to emerge from the water, but also to acquire an impetus which carries it the greater part of its glide), and that the planes of the wings can be inclined, all the movements of flying-fish which I have observed are fully intelligible.

W. N. F. WOODLAND.

"Kismet," Lock Mead, Maidenhead, June 4.

As another observer of Nature at sea I must beg to differ entirely from Dr. McNamara's conclusions on the "flight" of the flying-fish.

(1) Turning at an acute angle can be brought about by an extra puff of wind, and indicates no power on the part of the fish.

(2) It is impossible for a flying-fish to flap its pectoral fins as a bird does its wings.

(3) The rise and fall over waves are due to the forcing up or lowering of the air immediately over the surface of the water.

(4) The impetus is quite sufficient to send flying-fish up to a height of 50 ft. or even more, and to extend the soar to 300 yards. They naturally flop about on deck until dead.

(5) It is quite possible (though I have never seen it) for the tips of the fins to be vibrated by the wind during flight.

The matter has been dealt with more fully in "Nature Notes for Ocean Voyagers," by Capt. Alfred Carpenter and myself, and also in the *Nautical Magazine* for May, 1894, and in the *Shipping World* for April, 1901. The late Capt. Cromie, at my request, made a series of very careful observations from torpedo-boat destroyers and submarines, and was most emphatic that they did not "*fly*."

As in many other interesting problems, the help of a super-kinema camera fitted with a telephoto lens would be of great service. DAVID WILSON-BARKER.

Fellow-Workers.

IN NATURE for June 3, p. 416, Prof. D'Arcy Thompson refers to me and to my "fellow-workers" who helped me to bring our "hopes to fruition" in connection with the old malaria-mosquito business. My own memories remind me of seven years' almost continuous solitary labour, during which time my numerous "fellow-workers" had many opportunities, as good as mine or better, for doing the same work, but, oddly enough, did not use them; and it was not until I had solved the problem that they arrived on the scene in a body, fully armed with paper, pens, and cameras, and resolved "to join the victory group" at any cost. Prof. Thompson puts one of these gentlemen in the place of honour next to Pasteur—who, by the way, had little to do with the development of animal parasitology. The true history of the subject is given in my "Prevention of Malaria" (Murray), and still more trenchantly in Robert Koch's letter to me, dated February 10, 1901, and published in *Science Progress* for April, 1917.

But this is a detail: and I should like to thank Prof. Thompson for his kindly references to my medical verses, and for his interesting conspectus of the medical poets. Oddly enough, the day after it appeared in NATURE I lectured at the Royal Institution on "Science and Poetry," and upheld the thesis that a higher view of both will show how frequently and how closely they are connected. But honesty compels me to add that my own interest in medical matters is quite secondary, and a matter of duty rather than of predilection. RONALD ROSS.

36 Harley House, London, N.W.1, June 4.

The Approximate Evaluation of Definite Integrals between Finite Limits.

(1) THE four-ordinate rule given in my letter published in NATURE of May 20, p. 354, viz.

$$\int_0^1 F(x)dx = \tfrac{1}{4}\{F(\tfrac{1}{10}) + F(\tfrac{4}{10}) + F(\tfrac{6}{10}) + F(\tfrac{9}{10})\},$$

is obtained by dividing the range into two and to each half applying the simple two-ordinate rule,

$$\int_0^1 F(x)dx = \tfrac{1}{2}\{F(\tfrac{1}{3}) + F(\tfrac{2}{3})\},$$

the parabolic or cubic approximation for two ordinates being

$$\int_0^1 F(x)dx = \tfrac{1}{2}\left[F\left(\frac{3-\sqrt{3}}{6}\right) + F\left(\frac{3+\sqrt{3}}{6}\right)\right]$$
$$= \tfrac{1}{2}[F(0{\cdot}2113) + F(0{\cdot}7887)]. \quad . \quad . \quad (a)$$

(2) Closer approximations may be obtained by dividing the range into a greater number of parts and applying this rule to each, thus:

$$\int_0^1 F(x)dx = \int_0^{\frac{1}{3}} F(x)dx + \int_{\frac{1}{3}}^{\frac{2}{3}} F(x)dx + \int_{\frac{2}{3}}^1 F(x)dx$$
$$= \tfrac{1}{3}\left\{\int_0^1 F\left(\frac{x}{3}\right)dx + \int_0^1 F\left(\frac{1+x}{3}\right)dx + \int_0^1 F\left(\frac{2+x}{3}\right)dx\right\}$$
$$= \tfrac{1}{6}\{F(\tfrac{1}{15}) + F(\tfrac{4}{15}) + F(\tfrac{6}{15}) + F(\tfrac{9}{15}) + F(\tfrac{11}{15}) + F(\tfrac{14}{15})\}$$

The following table shows for several functions the value of the integral and the approximate evaluations from two, four, six, and eight ordinates:

$F(x)$	$\int_0^1 F(x)dx$	Number of ordinates used. 2	4	6	8
Semicircle $(x-x^2)^{\frac{1}{2}}$	0·3927	0·4000	0·3949	0·3939	0·3934
Quadrant $(1-x^2)^{\frac{1}{2}}$	0·7854	0·7898	0·7868	0·7862	0·7859
Parabola x^2	0·3333	0·3400	0·3350	0·3341	0·3337
$\sin x$	0·4597	0·4580	0·4593	0·4596	0·4596
$\log(1+x)$	0·3863	0·3850	0·3859	0·3861	0·3862
e^x	1·7183	1·7234	1·7197	1·7187	1·7186
$\frac{1}{1+x}$	0·6931	0·6945	0·6937	0·6934	0·6933

(3) If $F(x)=a+bx+cx^2+dx^3$,

$$\int_0^1 F(x)dx=\tfrac{1}{2}\left[F\left(\frac{2-\sqrt{2}}{4}\right)+F\left(\tfrac{1}{2}\right)+F\left(\frac{2+\sqrt{2}}{4}\right)\right]$$
$$=\tfrac{1}{2}[F(0{\cdot}1464)+F(\tfrac{1}{2})+F(0{\cdot}8536)]. \quad . \quad (b)$$

A simple three-ordinate rule is therefore

$$\int_0^1 F(x)dx=\tfrac{1}{3}[F(\tfrac{1}{7})+F(\tfrac{1}{2})+F(\tfrac{6}{7})].$$

In practice this is not quite so convenient as the application of the two-ordinate rule.

A. F. DUFTON.

Trinity College, Cambridge, May 20.

P.S.—I thank Mr. C. F. Merchant for pointing out in NATURE of June 3 that the four-ordinate rule is already in use, and for giving a reference to Tchebycheff's rules, with which I was unacquainted. The positions of Tchebycheff's ordinates, as in (*a*) and (*b*) above, are inconvenient, and the rules obtained by taking neighbouring ordinates attain simplicity without great loss of accuracy. A. F. D.

June 5.

The Cost of Laboratory Fittings.

IT is evident from the correspondence which has followed the publication of the letter from me on the subject of laboratory fittings that I must again ask leave to trespass on your space in order to explain that my remarks referred solely to fixed fittings, as stated, embracing working benches, lecture tables, and the like. I have no doubt that questions of actual instruments and apparatus are of much greater importance, but of these I have no right to speak.

Perhaps I may be allowed to make myself clear by reference to one or two specific directions in which research on fixed fittings might possibly prove useful. The present price of teak as bought in bulk from a merchant is 30*s.* per cubic foot, and if impregnated soft wood could be substituted for bench and table tops much saving would result. This impregnation might be effected by precipitation, electrolysis, oxidation (oils), or evaporation (*e.g.* silica solutions). Again, bituminous materials with perhaps barytes rolled into them might be investigated for use as a thin layer on wood or concrete. Soapstone is much used in America and *lave émaillée* in France, but not as yet in this country. There are, further, certain hard flooring plasters which should be very inert chemically. An investigation is much needed into the proper composition of bituminous materials for coating laboratory drains. Drains executed in wood thus coated are in many cases much cheaper than glazed ware drains.

For repetition work such as locker doors and even drawers pulped and stamped material might prove economical if some standard could be agreed upon. It should not be a very expensive matter to set on foot some researches of this nature, and any effective results would, I imagine, be very welcome to institutions at present faced with additions to their material equipment. ALAN E. MUNBY.

9 Old Square, Lincoln's Inn, W.C.2.

The First Act of a Young Thrush.

SINCE observations of the first acts of wild birds immediately after hatching are very difficult, the following may be worth recording. Last week I went to look at a thrush's nest which I had found a fortnight before, with four eggs in it. Two eggs were hatched and two were not. As I was watching the young birds, one of the two remaining eggs cracked right across, and I saw the bird wriggle out and toss the two halves of the shell out of the nest by a convulsive movement of its back; but the curious thing was that, before the bird was properly free from the shell, it opened its beak—as if for food. I dug up a worm near by and offered it to the bird, which swallowed it eagerly. I purposely dug for the worm in a place from which I could see the nest, and I feel sure that the parent bird did not come and feed the nestling meanwhile. A few minutes later the other egg hatched, and the bird behaved just as in the former case, opening its beak before it was out of the shell.

Now the question is: Was the opening of the bird's beak a reflex or an "instinctive" act? If it were reflex, it would presumably have been induced by sudden exposure to the new environment of open air; and, obviously, such a reflex act would serve the purpose of an "instinctive" one in this case. Moreover, is it not a question whether any "instinctive" act at so early a stage can be anything more than a reflex act thus adaptable to survival purposes—by natural selection if need be?

HONOR M. M. PERRYCOSTE.

Polperro, Cornwall, May 30.

Marat and the Deflection of Light.

CARLYLE'S vivid portraiture of Marat as "horse-leech" and savage revolutionist has rather obscured the fact that this "friend of the people" was a learned doctor of medicine, a physicist, and a physiologist. It is true that Carlyle refers to him as "Renovator of Human Science, Lecturer on Optics," but the mistake about the "horse-leech" is repeated in the same passage.

In Marat's "Notions élémentaires d'optique" (1784), p. 16, the following statement is made:

"Il est hors de doute, que les rayons de lumière changent toujours de direction dans le même milieu, lorsqu'ils passent à certaine distance d'un corps. Se trouvent-ils dans la sphère d'attraction? ils se replient jusqu'à certain point à sa circonférence, et se prolongent ensuite en droite ligne."

This at first glance may appear a remarkable anticipation of recent discoveries in physics, but in reality the conclusion is based on wholly false premises, as further reading of the pamphlet will disclose. W. A. OSBORNE.

University of Melbourne, April 22.

British and Metric Systems of Weights and Measures.

ON p. 355 of NATURE of May 20 Mr. M. E. Yeatman in a letter on the above subject says: "It seems that the advantage of any given system of weights or measures lies largely in the facilities that it offers for the division of a sum or quantity into equal parts"; and I have seen "facility of factorisation" claimed before as one of the merits of the British system. As an engineer who "figures frequently," I fail to appreciate this fetish of factorisation. One uses a slide-rule and logs, and never worries about factors. Will Mr. Yeatman, or someone else, demonstrate the use of factors in practical calculations, bearing in mind the use of slide-rules, calculating machines, and logs?

The metric system seems to be gaining ground in spite of the lack of factors disclaimed for it.

ALFRED S. E. ACKERMANN.

Aircraft Photography in the Service of Science.

By H. HAMSHAW THOMAS.

AIRCRAFT photography as developed during the war possesses great potentialities as an instrument of scientific research. The value of the aeroplane in geographical and geological exploration has already been emphasised in these pages, and its employment in the reconnaissance of little-known countries need not be further mentioned; but if aeroplane exploration is valuable, its worth is greatly enhanced by systematic photographic work. For, while a trained observer notices many features, it is quite impossible for him to observe and note more than the salient points seen from a swiftly flying machine, while the camera instantly records every feature in the field of view. Again, from a safe height of, say, 10,000 ft. only the larger elevations or depressions are visible to the human eye, but if paired photographs are taken for the purpose of stereoscopic examination with a wide base of, perhaps, 500 yards, then the whole of the ground relief becomes visible in a most striking manner. But not only do photographs provide a means of obtaining and recording information; they also show the relative positions of objects, and, if taken on an organised system, provide a topographical survey for use in map construction.[1] In addition, I was frequently struck with the value for scientific purposes of material obtained in the course of the R.A.F. work in Egypt and Palestine, and the purpose of this article is to indicate some types of information which may be furnished.

Air photographs may serve either as useful illustrations of known scientific facts, or as a means of discovering new facts, and while they are mainly of geographical or geological interest, they may also assist the botanist, archæologist, and meteorologist.

Geography and Geology.—As examples of the illustration of known facts, we may mention the remarkable photographs of Vesuvius taken by Group Capt. A. E. Borton, C.M.G. One of these has already been published in the Press, and it would not be easy to find a more striking demonstration of the structure of a volcanic cone. Among the photographs taken in Palestine we had many good illustrations of erosion and river development. The soft lake-beds of the Jordan valley were shown in the process of weathering out to form what the Americans term "bad-land topography." In this region marls and clays which have been baked by the hot, rainless summer are denuded at a great rate by the heavy winter rains, and give rise to a complex system of steep-sided wadis spreading back from the main drainage channels. The sides of these wadis are bare of vegetation, but their bottoms become filled with scrub when reduced to the base level of erosion.

[1] See *Geographical Journal*, May, 1920.

The contrast between the wadi forms produced in these lacustrine or alluvial deposits and those carved out of the adjacent Cretaceous rocks is very noticeable, and we have also illustrations of the different erosion forms produced on steep or gentle slopes.

The River Jordan, which had never been very accurately surveyed before the war, has now been photographed over a considerable distance, and furnishes striking examples of some of the phenomena of river development. In its lower part it has cut down a distinct and well-marked meander-belt below the level of the surface of the lake-beds of the old valley. The river is constantly changing its course in this belt (see Fig. 1), which in most places is well covered with vegetation, and the old courses of the stream are often plainly visible where the vegetation has not yet had time to colonise the former river-bed. We see "ox-bows" and loops of the river in all stages of development, while sometimes a heavy spring flood appears to have resulted in the stream taking an entirely new course. At the sides of the flood-plain cusp-like terraces often show the stages in the cutting down of the gorge, while the presence of hard beds may produce nodes in the series of meanders.

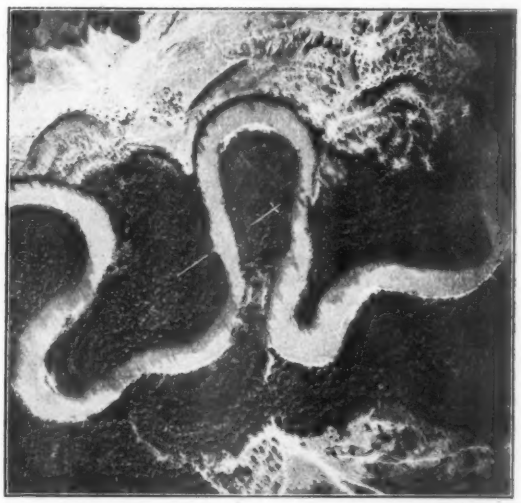

FIG. 1.—Meander belt of the River Jordan north of Jericho, showing the formation of an "ox-bow" and the cusp-shaped terraces. The dark area near the stream is the belt of willow scrub.

The illustrations of such features as have been mentioned are often so striking and convincing that they would be valuable to teachers and students if they could be made available.

But by the study of photographs and the maps

made from them we may observe other features of research interest. The story of the earth movements in the Jordan rift is not yet clear, while there has been much discussion about the climate of the region during recent and prehistoric times. In some of the photographs taken, we have good evidence of very recent faulting, and we may distinguish a fault scarp in the lake-beds (Late Tertiary). We find that the trough faulting has resulted in the incision of many of the tributary streams, and in several places in cañon formation. When we look at the drainage system from the point of view of climatic change we find evidence of a former period of abundant precipitation, during which much of the present surface sculpture of the Judæan hills was effected; but this period was a remote one, and preceded the drying up of the Jordan lake to give the present valley. Passing up to the north of Palestine, we have good evidence from a dry gorge, terraced valleys and drainage forms, that at a former period the River Jordan originated in Central Syria; but afterwards the Syrian portion of the river was captured by the Litani. This capture was largely the result of a general uplift of the country, and several of the oblique air views of the coastal plain of Palestine, especially near Mount Carmel, show very well the plain of marine denudation stretching from the present shore to the foot of the hills.

It is in the portrayal of the geographical features in the most complete and detailed fashion, so that their developmental story can be studied and deciphered, that aeroplane photography excels. If the whole of the Palestine material could be carefully studied by the physical geologist, a great deal of information would result, for the above-mentioned deductions have been made from the study of a few small sets of photographs which had been chosen at random for other purposes.

The investigator of solid geology has naturally little to learn from photographs, but in some places, where the climate is arid and the ground almost devoid of soil, the boundaries of some of the harder beds may become visible, while in other cases the bedding is clearly seen, and the underlying structure may be brought out by surface weathering. A photograph taken during the first flight ever made from Egypt to India showed an interesting locality in western Persia, where a well-marked anticline had been laid bare by surface erosion.

Botany.—The student of vegetation who may be sufficiently fortunate to obtain aerial photographs of the ground is at once in possession of the basis of an ideal vegetation map. Different types of vegetation show up very clearly, and also, of course, the transition from desert to open and closed plant associations (see Fig. 2). It is naturally necessary to go over the ground with the photographs, but after a short time the characteristic tones and appearance of different vegetation types can be readily picked out. Even among crops it is possible to distinguish barley, wheat, and maize, besides other plants, like cotton, which have a distinct habit and growth period. Practical use of these facts was made in Mesopotamia for ascertaining the acreage under wheat cultivation, and trials have been made in India with the view of carrying out crop-surveys by aeroplane photography.

I have not had the opportunity of making many observations on this subject, but it may be of interest to mention a small point observed in connection with the distribution of the willow and tamarisk scrub of the Jordan valley. This vegetation is limited by the water supply from the river, and succeeds in following the stream right down to the Dead Sea. Here, at the mouth of the Jordan, although surrounded by salt lagoons, a narrow belt of vegetation manages to survive as a fringe to the river with its rapidly flowing stream of fresh water.

Archaeology.—The utility of aerial photography to the archæologist was strikingly illustrated in

FIG. 2.—Photograph showing the distribution of vegetation in the Sinai desert. The partial colonisation of sand-hills by dwarf scrub vegetation —the black spots—is well shown, also some small groups of date palms.

the case of the ninth-century city of Samarra,[2] in Mesopotamia, where views taken from above the apparently formless heaps of earth and rubble give the outlines and plan of streets and buildings. It may be only rarely that similar cases may arise, but experience shows that if ruins or remains exist in any regular form, their arrangement will be well depicted by the aeroplane camera. We may by this means be able to locate interesting sites which have been more or less obscured by superimposed material. A feature which was brought to light in Palestine as the result of air survey was the ancient irrigation system in the south-eastern part of the Jordan valley. An extensive series of old connected channels, now filled with scrub vegetation, was seen; this must be a relic of the days when the Jordan valley was under general cultivation,

[2] See LT.-COL. G. A. Beazley, *Geographical Journal*, vol. liii., p. 339, 1919.

and very different from the desert condition which it possesses to-day. While nothing was found in Palestine of the same type as the Samarra ruins, the ancient Græco-Roman temples of Jupiter and Bacchus at Baalbek, in Central Syria,

FIG. 3.—Temples of Jupiter and Bacchus at Baalbek in Central Syria, showing the ground plan and some remains of later Saracenic building.

furnished some interesting photographs. A vertical view from about 3000 ft. gives a remarkably good ground plan of the present state of these beautiful remains (see Fig. 3).

Meteorology.—The study of clouds by the photography from aeroplanes of their forms and features has been recently discussed by meteorologists, and need not be further mentioned.

It would be outside the scope of the present article to deal with the methods of obtaining, using, and interpreting the aerial pictures which have been referred to. It may be seldom possible for a scientific expedition to employ aeroplanes, owing to their expense; but, when it can be done, useful knowledge is bound to accrue. In other cases, however, as in Palestine, photographs may be taken for mapping or other purposes, which will also yield important scientific material to those who can make use of it; and possibly photographs taken for the purpose of training airmen may become of great value, even in this country, if certain areas are included. Sometimes the evidence furnished is clear and unmistakable, but in other cases the photographs have to be examined by a trained and experienced worker. The general public has not been very fully informed of the work of the R.A.F. photographers during the war, and to most people the air photograph is a curiosity which seems to have little value in times of peace. Though in some countries the civil importance of aerial photographic survey is realised, in England air photography is in a somewhat languishing condition. In these circumstances it is well to remember that, though the aerial camera has not been extensively employed apart from military work, it nevertheless appears to have no inconsiderable value in the domain of pure science.

The Dynamics of Shell Flight.

By R. H. FOWLER.

THE object of this article is to give a short account of some features of the motion of a spinning shell through air. Our knowledge of this phenomenon has been somewhat increased by war-time researches. To determine the motion of a shell from the equations of rigid dynamics, we require to know the complete force system which represents the reaction of the air on the moving shell; but, just as in the case of an aeroplane, the components of this reaction are utterly unknown *a priori*. The problem that arises, therefore, is that of determining these components by observation and analysis of the actual initial motion of shells. Once they have thus been determined, they can be applied, provided the essential conditions remain similar, to the calculation of the complete motion of a shell along its trajectory.

In the simplest case of all this procedure is classical. The air resistance to a shell, moving so that the directions of its axis and the velocity of its centre of gravity coincide, has long been determined thus as a function of the velocity, and trajectories have been computed assuming that this coincidence subsists throughout the motion. Under this assumption the problem is merely one of particle dynamics, of which the solution may be regarded as completely known. The comparison of calculations and observations shows good agreement in range and height when the shells are suitable and the total angle turned through by the tangent to the trajectory is less than, say, 50°. The calculated trajectory, however, is a curve lying in the vertical plane containing the original direction of projection, while the observed positions of the shells do not lie in this plane, but appreciably to the right of it when their axial spin is right-handed. This well-known departure from the original vertical plane is called *drift*, and converts the trajectory into a twisted curve. It cannot be accounted for on the original assumption.

It is with these cases, in which particle dynamics fails to explain the observations—such as the drift, trajectories of large total curvature, and (as we shall see) initial motions—that we are mainly concerned here. For their study we must abandon the assumption that the direction of motion of the centre of gravity and the direction of the axis of symmetry coincide, and study the whole motion as a problem in rigid dynamics.

In order to do this we must, first of all, deter-

mine experimentally the complete reaction of the air on the moving shell when the directions of its axis and the motion of its centre of gravity no longer coincide. In such a case the angle between these two directions is called the *yaw*. Until recently the reaction on a yawed shell had never been studied experimentally. The necessary data, however, can be obtained by observation and analysis of the initial motion of the shell in the first few hundred feet after leaving the muzzle of the gun, for in this interval the axis of a shell oscillates periodically over an appreciable range of yaw.[1] The motion is a little complicated, and its interpretation is not yet completely worked out in terms of the reaction of the air. Moreover, a really satisfactory experimental method has not yet been devised. But a start has been made on the problem, and approximate values of the more important components have been determined.[2]

The somewhat crude experimental method so far used consists in firing a shell through a series of cardboard screens. The shape of the hole in the card determines the size and direction of the yaw at the instant of passing through the card. From such observations the motion of the axis can be plotted out against the time (if the velocity of the shell is known), and the period of its oscillations determined. The disturbing effect of the cards themselves can be determined by suitable control experiments and roughly estimated. Two specimen observed curves[3] traced out by a point on the axis of the shell relative to the centre of gravity are shown in Figs. 1 and 2. These two paths are strictly comparative, as the only difference between their circumstances is an alteration of the axial spin. The slowly spinning shell (Fig. 1) has oscillations of comparatively long period and large amplitude. These curves are closely analogous to the curves which represent the oscillations of a spinning top near its vertical position. They differ only in showing slight damping and variation of period.

Let us consider further this analogy between a shell and an ideal spinning top. The centre of gravity of the shell and the point of support of the top are analogous; so are the moments of inertia about these points and the axial spins. To the direction of motion in the case of the shell corresponds the vertical in the case of the top; to the disturbing couple due to the reaction of the air on a yawed shell corresponds the gravity couple on a displaced top. The analogy so far is practically exact; it is modified by the following facts:—

(1) That the centre of gravity is not a fixed point like the point of a top, for its velocity varies both in magnitude and in direction under the reaction of the air; it describes a helical curve, thus modifying the couple.

(2) That an appreciable frictional couple exists which, in conjunction with the helical motion of the centre of gravity, serves to damp out the axial oscillations completely.

(3) That, in addition to (1) above, the magnitude and direction of the velocity of the shell are steadily altered by gravity.

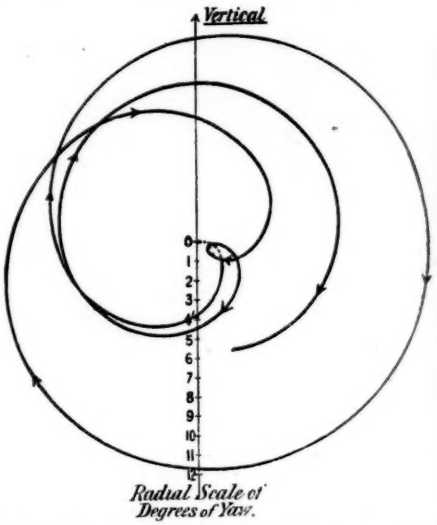

FIG. 1.—Observed path of the nose of a shell, muzzle velocity 1565 f.s. Rifling 1 turn in 40 diameters of the bore. Total time taken to describe curve shown 0.38 sec.

Experiments so far carried out have determined approximately the values of the couple analogous to the gravity couple for velocities from 900 f.s. to 2200 f.s. for two different shapes of shell, when the yaw is not too large. By determining these couples for various different positions of the centre of gravity, rough values of the resulting sideways thrust on a yawed shell were deduced.

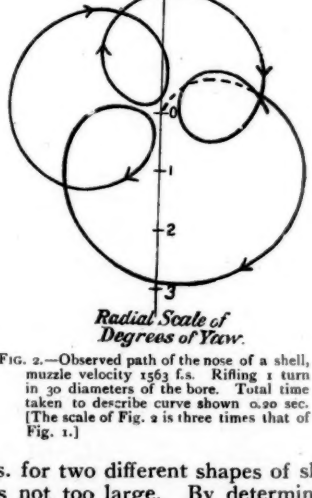

FIG. 2.—Observed path of the nose of a shell, muzzle velocity 1563 f.s. Rifling 1 turn in 30 diameters of the bore. Total time taken to describe curve shown 0.20 sec. [The scale of Fig. 2 is three times that of Fig. 1.]

[1] Such experiments are described in a forthcoming paper in the Royal Society Transactions by R. H. Fowler, E. G. Gallop, C. N. H. Lock, and H. W. Richmond.

[2] The forces on a model shell at rest in a steady current of air of low velocity can also be measured directly in a wind channel; the results are probably applicable to a shell moving at velocities up to 700 f.s.

[3] The observations were made for the Ordnance Committee at H.M.S. *Excellent*, Portsmouth.

The study of initial motions is intimately connected with the question of the *stability* of a spinning shell at zero yaw. The motion of a shell (or a top) is said to be stable if a small disturbance only produces a small maximum displacement from the position of symmetry, proportional to the disturbance. The condition of stability for small disturbances is the same in the two cases; it must be fulfilled in order that the shell may travel along its trajectory approximately at zero yaw as desired. A knowledge of the disturbing couple enables us to lay down how much spin is required to allow a reasonable margin of stability.

We have said that the usual approximation of motion at zero yaw is inadequate in the case of trajectories of large total curvature. The complete theory indicates that, under the effect of gravity (see (3) above), the yaw tends to attain a sort of equilibrium value which increases along the trajectory, and may reach 20° or more at the end of a sufficiently long arc. A study of initial motions with slightly unstable shells in which such values of the yaw can be realised experimentally will provide the material required for the proper discussion of such trajectories.

The following approximate theory accounting for the drift of a shell has long been known. Owing to the change of direction of motion due to gravity (see (3) above), a shell cannot continue to move steadily at zero yaw. The proper equilibrium state of affairs is attained when the yaw is just such as will enable the axis to keep pace with the changing direction of motion by precession about it. This equilibrium value of the yaw depends on the above-mentioned disturbing couple due to the reaction of the air, which may be determined by a study of the initial oscillations. The resulting yaw in ordinary cases is too small to alter seriously the range at any given time, and does not affect the height because the equilibrium position of the yawed axis lies in a plane which is always very nearly at right angles to the vertical plane containing the original direction of projection. It produces, however, the lateral deviation known as drift. This approximate theory leads to a formula for the drift depending on the ratio of the sideways thrust to the disturbing couple. With the values of this ratio recently roughly determined, the drift has been calculated by this classical theory, and compared with direct observations of the drift of similar shells. The observed and calculated values are in fair agreement, and there is no doubt that the classical theory is substantially correct.

In conclusion, it is perhaps worth mentioning that the interest in such investigations mainly arises from the fact that we can thus study the phenomena of motion through a compressible fluid at velocities both greater and less than the velocity of sound in the fluid. The investigation, however, has scarcely begun, and much work will be required before it is possible to describe adequately the complete reaction on a shell of given shape moving through air.

Obituary.

PROF. L. DONCASTER, F.R.S.

LEONARD DONCASTER'S death from sarcoma at the age of forty-two has stopped a career of exceptional distinction. When I lately saw him, apparently in his usual health, presiding over his laboratory as the newly elected Derby professor of zoology at Liverpool, I had comfort in the thought that by his appointment a fresh centre of genetics was safely begun. Doncaster was a natural investigator. From his student days there was never a doubt as to the purpose of his life. The problems of biology were always in his mind. For him the materials were everywhere. Though circumstances led him into academic zoology, he was an excellent field entomologist and botanist, with a fair knowledge also of the domesticated forms. Latterly he became more and more drawn towards cytological methods, but he always kept in touch with the other lines, knowing that the next advance may begin anywhere.

Doncaster started at Naples with experiments on hybridisation of Echinoderm larvæ, which produced evidence of value as to the effects of temperature in modifying dominance; but many aspects of that vexed question remained, and still remain, obscure. He returned to England at the moment when the early struggles of Mendelism were acute. Though constitutionally predisposed to caution, he knew enough of the general course of variation and heredity to be in no doubt of the essential truth of the new doctrines, and undoubtedly his adhesion did much to spread confidence among his contemporaries. He at once joined in breeding work, and at various times experimented with many forms, particularly rats, cats, and pigeons. With insects of several orders he was especially successful. The seemingly more fundamental nature of microscopical work made it very congenial to him, and he always had a mass of cytological material on hand. These studies enabled him to take a prominent part in that comprehensive codification by which the confused and contradictory observations as to the sexes of parthenogenetic and other forms in the Hymenoptera and Hemiptera were ultimately reduced to order.

In the history of biology Doncaster's discovery as to the determination of sex in the currant moth (*Abraxas grossulariata*) will have a permanent place. From the Rev. G. H. Raynor, a fancier of the species, he learnt facts which suggested that the variety *lacticolor* was what we now call "sex-linked," being predominantly associated with females, as colour-blindness in man is with males. After verification and extension this mass of facts provided (1906) the first clear genetic proof of

sex-determination in the gamete, a discovery of astonishing novelty at that time, though now so familiar to us all that we have forgotten how hard it was to achieve. Being greatly struck with Wilson's cytological proof that many *male* insects are heterozygous for sex, and having himself proved that in Abraxas the female is in this condition, Doncaster devised a scheme in which both sexes are thus represented, dominance being attributed to the female gamete; but he afterwards accepted a simplifying emendation in which the male is taken to be homozygous. After this, finding a curious strain in which half the females produce daughters almost exclusively, Doncaster showed that these females generally had only fifty-five chromosomes instead of the normal fifty-six. By reasoning analogous to that afterwards used by Bridges in his famous paper on "non-disjunction," he attempted a cytological interpretation, though, as he admitted, the solution was imperfect, and the case is still mysterious.

Progress was also made with the paradox of tortoiseshell cats, known by fanciers to be almost exclusively females. Doncaster proved that tortoiseshell is the female heterozygote of orange and black, the corresponding male being orange; and in the course of wide inquiries he discovered the new fact that the rare tortoiseshell tom is often *sterile*. In his last paper he conjectured, not without probability, that, in view of Lillie's extraordinary discovery as to the free-martins of cattle, these males may owe their peculiarities to the intra-uterine influence of other embryos. Most of these subjects are discussed in his text-book, "The Determination of Sex," 1914. Just before his death Doncaster published an admirable "Introduction to the Study of Cytology," in which he declared himself with reservation a convert to the views of Morgan—a judgment which, from so critical an observer, must carry great weight.

His death will be cruelly felt. At a time when cytology is becoming a subject of primary importance, the loss first of R. P. Gregory and now of Doncaster leaves us bereft indeed.

Doncaster was one of the clearest-headed men I have known, and, being full of both enthusiasm and knowledge, he taught extraordinarily well. In Cambridge he served in various capacities, and was for four years in the University of Birmingham. As Prof. Herdman has written, his death is "nothing less than a calamity to Liverpool University." Doncaster was slight in figure and of a nervous temperament, feeling and thinking of everything with intensity, though nevertheless a fluent speaker. He came of a Quaker family, being the son of Samuel Doncaster, manufacturer, of Sheffield, in whose beautiful garden he developed his love of plants. Educated at the Friends' School at Leighton Park, Reading, he went up as a scholar to King's College, Cambridge, of which he afterwards became a fellow. He married in 1908 Dora, daughter of Walter Priestman, of Birmingham, and leaves three children.

We did not speak of such matters, but it was known to his friends that Doncaster had religious instincts strongly developed. The years of the war were to him more hateful even than to most thoughtful men. He held the Friends' attitude of the unlawfulness of war, but, feeling that alternative service was a duty, he gave up his researches and qualified as a bacteriologist, working in the 1st Eastern Hospital, Cambridge, and afterwards in the Friends' Ambulance Unit at Dunkirk.

W. BATESON.

MR. JOHN W. HYATT, of Newark, New Jersey, whose death is reported at the age of eighty-two, was the inventor of celluloid. He was a printer by trade, and was using collodion in the course of his work when he accidentally overturned a bottle, and the idea of celluloid came to him from watching the collodion solidify. He took out 250 patents in all, a large majority of which had an important bearing on manufactures. They included a billiard-ball composition, a roller bearing, a system of purifying water for domestic use, a sewing machine capable of sewing fifty rows of lock-stitches at once, a machine for extracting juice from sugar cane, and a new method of solidifying American hardwoods. In 1914 Mr. Hyatt was awarded the Perkin medal of the New York Society of Chemical Industry.

WE much regret to see the announcement in the *Times* that PROF. AUGUSTO RIGHI, For. Mem. R.S., died suddenly at Bologna on June 8 at seventy years of age.

Notes.

THE list of honours conferred in celebration of the King's Birthday includes the following names of men associated with scientific work:—*Irish Privy Councillor:* Mr. H. T. Barrie, Vice-President, Irish Department of Agriculture. *K.C.B.:* Sir A. W. Watson, president of the Institute of Actuaries. *C.B.:* Mr. A. W. Flux, Assistant Secretary, Board of Trade. *Baronet:* Mr. P. J. Mackie, who financed the Mackie Anthropological Expedition to Uganda and other expeditions. *Knights:* Prof. F. W. Andrewes, F.R.S., pathologist at St. Bartholomew's Hospital; Capt. D. Wilson-Barker, captain-superintendent of the training-ship *Worcester*, and past-president of the Royal Meteorological Society; Dr. J. C. Beattie, Principal of the University of the Cape of Good Hope; Mr. W. B. M. Bird, founder of the Salters' Institute of Industrial Chemistry; Dr. H. H. Hayden, Director of the Geological Survey of India; and Prof. J. B. Henderson, professor of applied mechanics, Royal Naval College, Greenwich. *C.I.E.:* Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, and Mr. R. S. Pearson, Forest Economist, Research Institute, Dehra Dun. *K.B.E.:* Dr. J. Dundas-Grant, eminent aural specialist; Dr. J. C. Stamp, distinguished economist; and Col. W. Taylor, ex-president of the Royal College of Surgeons in Ireland. *Companions of the Imperial Service Order:* Mr. R. B.

Newton, assistant in the Department of Geology, British Museum (Natural History); Dr. W. Eagle Clark, keeper of Natural History Department, Royal Scottish Museum, Edinburgh; and Mr. R. Duncan, Staff Officer, Veterinary Branch, Department of Agriculture and Technical Instruction, Ireland.

THE following decorations have been conferred upon scientific workers in recognition of valuable services rendered during the war, and the King has granted permission to wear them:—Conferred by the King of Italy—Order of the Crown of Italy: *Chevalier:* Mr. H. D. Roberts, director of Public Library, Museums, and Fine Art Galleries, Brighton. Order of St. Maurice and St. Lazarus: *Officer:* Sir Douglas Mawson, Dr. T. M. Lowry, F.R.S., and Prof. P. F. Frankland, F.R.S. Conferred by the King of the Belgians—Order of the Crown: *Grand Officer:* Sir Alfred Sharpe. *Commander:* Prof. W. Somerville. *Officer:* Dr. E. J. Russell, F.R.S. *Chevalier:* Mr. C. E. Fagan, Mr. A. R. Hinks, F.R.S., secretary of the Royal Geographical Society, and Mr T. McRow. Order of Leopold II.: *Commander:* Dr. W. R. Dunstan, F.R.S., director of the Imperial Institute, and Prof. G. H. F. Nuttall, F.R.S.

IT is announced in *Science* that the U.S. National Academy of Sciences has recently elected the following foreign associates:—Frank Dawson Adams, McGill University; Marie Ennemond Camille Jordan, Collège de France; François Antoine Alfred Lacroix, Musée d'Histoire Naturelle, Paris; Heike Kamerlingh Onnes, University of Leyden; Sir David Prain, Royal Botanic Gardens, Kew; and Santiago Ramon y Cajal, University of Madrid.

MR. O. F. BROWN, assistant inspector of wireless telegraphy in the Post Office, has been appointed Technical Officer to the Radio Research Board, which has been formed recently under the chairmanship of Admiral Sir Henry Jackson, in connection with the Department of Scientific and Industrial Research.

SIR W. J. POPE, F.R.S., was elected an associate of the section for the mathematical and physical sciences of the Académie Royale de Belgique on June 5.

COL. H. G. LYONS has been appointed director and secretary to the Science Museum, South Kensington, in succession to Sir Francis Ogilvie, who has been transferred to the Department of Scientific and Industrial Research.

PROF. FLINDERS PETRIE in *Ancient Egypt* (1920, part ii.) describes a remarkable statue of ebony 27 in. high. "The pose of the standing position is more thrown back than in the Old Kingdom, from the waist upward. The head has had inlaid eyes, now missing. The expression is marvellously vigorous and full of vitality, and it differs from other Egyptian figures not only thus, but also in the type. The very wide jaw, short chin, and high cheek-bone have hardly a parallel in other statues. It is clearly one of the great masterpieces, and of a rare style of work." It is stated to have come from the Eleventh Dynasty temple at Deir-el-Bahri, and may represent one of the Mentuhetep kings, but the provenance is so uncertain that it is difficult to identify it. "When workmen are not well rewarded for the objects found, much is taken away without any record of the original place and connection. If we knew the position to which the figure belonged, the burial chamber, the royal shrine, the family shrines, or elsewhere, we might have fixed the historic value of one of the most striking portraits known from Egypt."

MR. J. BRONTÉ GATENBY, whose papers on the cytoplasmic inclusions of the germ-cells have formed such a conspicuous feature of the *Quarterly Journal of Microscopical Science* during the last few years, contributes to the last number of that journal (vol. lxiv., part 3) a valuable account of the modern technique of cytology, which, taken in conjunction with his recently published paper on "The Identification of Intra-cellular Elements" (Journal of the Royal Microscopical Society, 1919), should prove of great use to students of microscopical zoology. These papers will place within reach of all many of the numerous modern refinements of technique which are indispensable to future progress, and the use of which bids fair to increase to a very great extent our knowledge of cell morphology and development. We are glad to learn that the author has also undertaken to edit a new edition of that classical and widely appreciated work, Bolles Lee's "Microtomist's Vade Mecum."

IN sending the Report of the Curator of the Somerset County Museum, Taunton Castle, for the year ended September 30, 1919, Mr. H. St. George Gray directs our attention to three graphs showing (1) the annual increase in membership of the Somersetshire Archæological and Natural History Society since 1880; (2) receipts from entrance fees to the museum for the years of this century; (3) fluctuations in the number of visitors during the same period. We are not prepared to admit offhand that this is the first application of graphic curves to society and museum statistics, but the results are undoubtedly illuminating, and, in this case, raise interesting questions for the consideration of those directing the policy of the museum. If such charts, with more frequent time-intervals, were prepared on a consistent plan by all institutions of the kind, their comparison would bring new light to social and economic studies.

THE *Museums Journal* for April–May prints a weighty report on the relation of museums to the advanced student, presented to a British Association Committee by a strong sub-committee. It is claimed that the interests of the serious student should not be sacrificed to those of the general visitor. The needs of the researcher, university student, private student, and collector are considered, and practical recommendations are based on experience. In view of the proposed site of London University, it is interesting to find the report urging closer co-operation between universities and museums. "The student may fairly be asked to help by doing some curatorial work. . . . The museum will profit by the improved arrangement of the objects, and the student will learn how to utilise specimens and how to discover the relevant literature." The student should be supported by "a

system of scholarships, held on the double condition of carrying out in the museum research work and curatorial work satisfactory to the professor and the curator respectively."

AN interesting addition to the literature on the subject of the relationship between light and plant-growth appeared recently in the *Journal of Agricultural Research* (vol. xviii., No. 11, March, 1920). In this paper W. W. Garner and H. A. Allard discuss the effect of the relative length of day and night, and of other environmental factors, on growth and reproduction. Their results show that the relative length of the day is a factor of the first importance in plant growth, particularly with respect to sexual reproduction. The effect on sexual reproduction of environmental factors such as temperature, water-supply, etc., seems to be simply one of acceleration or retardation so long as these factors are within a normal range. The seasonal length of day, however, may actually initiate the reproductive processes or inhibit them, according as to whether the given length of day is favourable or unfavourable for the particular species. If the length of day is unfavourable to sexual reproduction, but favourable to growth, then vegetative development is continued indefinitely; but if the length of day is favourable to both reproduction and growth, then the period of sexual reproduction is extended. The seasonal range in the length of day is therefore an important factor in plant distribution, and, moreover, the relation between length of day and reproduction emphasises the great necessity for seeding crops at the proper time.

IN Publication No. 295 of the Carnegie Institution of Washington, entitled "A New Type of Hereditary Brachyphalangy in Man," Messrs. Otto L. Mohr and Chr. Wriedt illustrate the heritability of a trivial character for six generations. The character is a symmetrical shortening of the second joint of the second fingers and toes which recurred without any break for six generations within a Norwegian family, some members of which emigrated to America. Without exception the peculiarity was restricted to the particular phalanx mentioned, the hands and feet being in other respects quite normal. There was no associated shortness of stature. The anomaly manifests itself under two distinctly different somatic types, one "slightly" shortened and generally overlooked by the affected individuals, the other "much" shortened and very striking. No case of an intermediate condition was observed. The brachyphalangy is inherited as a dominant, not as a sex-linked, character. The numerical ratio between the affected and unaffected individuals in the offspring of brachyphalangous members of the family is in accordance with the theoretical Mendelian expectation. All the brachyphalangous individuals are heterozygous for the gene in question, with one possible exception. The material includes a case of identical twins, both showing the same type of brachyphalangy. A genetic explanation of the occurrence of the "slightly" shortened and the "much" shortened types is suggested. The authors are to be congratulated on their careful working out of an interesting case.

ON Friday, June 4, the Association of Economic Biologists and the Imperial Entomological Conference held a joint meeting at the Rothamsted Experimental Station, Harpenden. The greater part of the day was devoted to an examination of the field experiments which were demonstrated by Dr. E. J. Russell and Dr. Winifred E. Brenchley. The park grass plots have been under grass for some centuries; it is not known that seed has ever been sown, and at the beginning of the experiments (1856) the herbage on all the plots was apparently uniform. The twenty-three plots are each manured differently, the same treatment being maintained year after year, and the southern half of each plot is limed. The difference in the vegetation on the several plots is now most remarkable, and, quite apart from the great and immediate practical value of the experiments, they are an ecological demonstration of the very first importance. The Broadbalk wheat field is perhaps the most famous single field in the world. Here wheat has been grown continuously since 1843, the eighteen plots receiving different manurial treatment which has been maintained year after year. The knowledge already yielded by Broadbalk has served almost to revolutionise the earlier ideas concerning the growth and needs of the wheat-plant and the nature of the soil, and the attention now being concentrated upon it by physicist, chemist, statistician, protozoologist, entomologist, mycologist, and algologist should continue the good work begun by Lawes and Gilbert, and so ably sustained by Sir Daniel Hall and the present director. After tea Dr. A. D. Imms opened a discussion on "Tropisms," giving a brief account of his own investigations on chemotropism, and relating these to the general theory of tropisms formulated by Loeb. A paper specially contributed by the latter author was read, and Dr. Tillyard, of New Zealand, Mr. E. E. Green, Dr. Williams, Sir J. C. Bose, Mr. W. B. Brierley, and Prof. Neilson Jones took part in the discussion that followed.

AN interesting case of extreme differentiation of types of igneous rock, in which the whole series is accounted for by gravitational separation, is described concisely by Mr. H. C. Cooke in "The Gabbros of East Sooke" (Canada Geol. Survey, Museum Bull. No. 30, 1919). In view of the use of the mineral name "anorthose" for soda-microcline, objection may be taken to the term "anorthosite" for rocks with felspar akin to anorthite.

PROF. G. CESÀRO sends us a paper on minerals from Monte Somma and Vesuvius, which is of interest as having been prepared for issue in the Bulletin de la Classe des Sciences of the Académie royale de Belgique in 1914, and actually circulated by its author in 1919. Prof. Cesàro has meanwhile, by the stress of war, become personally known to a circle of British mineralogists, who will maintain cordial relations with him despite his return to his own country. As an appendix to the paper Prof. Cesàro describes an apatite from Cornwall as having a low birefringence, and therefore a high fluorine content, and in dealing with similar apatite from Vesuvius he quotes from his previous work the relations between the fluorine present and certain angles of the crystals.

BULLETIN No. 22, part i., of the Geological Survey of New Zealand, on the limestone resources of the country, by Mr. P. G. Morgan, is really a treatise on limestone and its uses, illustrated from occurrences in New Zealand. It is thus exactly suited to local requirements; but both it and its successor on the phosphates will be welcomed in a much wider field. Attention is well given to the use of lime and of ground limestone on the land. The literature to be consulted is wide, but we note that all the papers named as of a general character are of American origin. We thus miss the work of Messrs. Hutchinson and MacLennan at Rothamsted, published in the *Journal of Agricultural Science* in 1915. Mr. J. A. Hanley's account of his experiments with various limes in Yorkshire (Journ. Soc. Chem. Indust., 1918) is probably too recent for inclusion, since communications have been disturbed by war; but for some years past there have been indications that authors and publishing bodies in the United States have been more mindful than ourselves of libraries in the Pacific region. This should be a reminder for Britons, who are the true begetters of the enterprising island folk.

THE Executive Committee of the Advisory Council of Science and Industry of the Commonwealth of Australia has issued the third and concluding part of an exhaustive report by Dr. F. L. Stillwell upon the factors influencing gold deposition in the Bendigo goldfield. As is well known, the mode of occurrence of the gold reefs in this field is quite unique, and its peculiarities have given rise to much discussion, so that the thorough investigation here presented should be of great interest to all students of mineral deposits. The general conclusions arrived at are that the form of the reefs is due primarily to that of the original fracture through which the depositing solutions have percolated; that all the large and important reefs have been in some way associated with faults, the latter being generally contemporaneous and connected with the folding of the rocks, the faults having given rise to a network of fractures which afforded a passage to the mineralising solutions; and that the deposition of the gold from these solutions has been brought about in three ways: (1) Precipitation from the auriferous solution; (2) crystallisation from a supersaturated solution; and (3) crystallisation from solutions the supersaturation of which is due to decreasing temperature after the main portion of the gold has been precipitated. The first of these is the most important method of deposition, and appears to be closely connected with the presence of carbonaceous matter.

IN his address to the Royal Geographical Society at the anniversary meeting on May 31, Lt.-Col. Sir Francis Younghusband pleaded for a wider outlook in geography and freedom from a strictly utilitarian viewpoint. A knowledge of the beauty of the earth may be legitimately included within the scope of geographical science. Beauty of scenery in many instances is the most noteworthy characteristic of a country and its most valuable asset. Advertisements of tourist organisations, railway and steamship companies, and even emigration departments, bear constant witness to the importance of this aspect. Moreover, natural beauty is inexhaustible, while mineral wealth is limited and agricultural productivity not unbounded. Sir Francis Younghusband contended that the geographical knowledge of a country was incomplete without a knowledge of its beauty, and that by this means alone can the geographer gain a sense of the earth "as live, supple, sensitive, and active." Continuing, he pointed out that there should be less hesitation in accepting this principle when it is realised that natural beauty affects the movements of man, and that man is having an increasing effect on natural beauty, often, but not always, with disastrous results. This relationship between man and the beauty of the earth is one of which geography should take as much cognisance as it does of the relationship between man and the productivity of the earth. The knowledge of beauty must be carefully gathered. Careless snapshots and shallow rhapsodies in guide-book style are unsatisfactory. We require the best photographs as well as paintings and accurate descriptions of literary merit. The artist both in pencil and in words is essential in geographical work.

IN the *Meteorological Magazine* for May a notice is given of the circulation of forecasts by wireless telegraphy from collective weather reports for London and south-east England. Hourly reports of meteorological information prepared by the Forecast Service of the Meteorological Office are sent out from the wireless station at the Air Ministry. The message is given in a code form, which is practically the same as that prescribed in Annex G of the "Convention relating to International Air Navigation," Paris, 1919. The forecasts, which are being issued eight times a day, are based on observations taken about half an hour before the time of issue. Detailed explanation of the code can be obtained on application at the Meteorological Office. A new device is also mentioned for making the meteorological reports rapidly available to the public. A large weather map is exhibited daily at the Air Ministry in one of the front windows on the ground floor of Empire House, Kingsway. All the principal reporting stations in the British Isles, as well as a few neighbouring Continental ones, are marked on the chart, which is on the Mercator projection, and is 10 ft. high and 6 ft. wide. The information on the chart is changed at about 3h., 8h. 30m., and 14h. 30m. G.M.T., the data exhibited referring to observations made at 1h., 7h., and 13h. G.M.T. The exceptionally wet character of April is well shown in the Thames Valley Rainfall Map, where upwards of 5 in., and in places more than 6 in., of rain occurred during the month over the western portion of the valley. Districts with less than 2 in. are rare, and almost entirely confined to the neighbourhood extending from London to the mouth of the Thames. In England and Wales the general rainfall for April was 204 per cent. of the average.

FOR many years the utilisation of the water-power of the Rhone has attracted attention in France. The shortage of coal has renewed interest in the problem,

which is now on the road to solution. The Chamber of Deputies has taken the matter in hand, and agreed to proposals which now await consent by the Senate. According to an article by M. M. Fourniols published in the *Revue générale des Sciences* for May 15, the plan is to divide the river into six sections, to be managed separately or preferably by a single body. Concessions are to be for seventy-five years' duration, and will be helped by State loans. Besides the utilisation of water-power, the project embraces the improvement of navigation, the creation of river ports, and the construction of irrigation works. At present the conditions are not favourable for navigation, but the recently opened canal from Marseilles to Arles opens a new vista of possibilities in cheap river connections with the sea. It is proposed to erect a number of power stations between Genissiat, near the Swiss frontier, and Comps, near Tarascon. Genissiat with 200,000 h.p. will be the largest, and will probably supply power to Paris. Other important stations will be near Lyons, Valence, Montelimar, and Mondragon. A form of dam and locks is projected which will interfere as little as possible with navigation.

IN an article in the *Revue Scientifique* for May 22 M. A. de Gramont de Guiche, president of the council of the Institute of Optics of France, describes the arrangements made for the first session of the institute, April to July, of the present year. The institute is divided into three sections: (1) A school of higher studies intended to provide the training requisite for the specialists in the subject; (2) a laboratory for research and practical instruction; and (3) a school for the training of the workmen and craftsmen both in glass- and in instrument-making. At the opening of the course on April 12 M. Jobin, one of the members of the council, described in detail the objects of the institute and the steps that were being taken to carry out those objects, and Dr. Dunoyer gave the first lecture of a course on optical instruments. Other lecture courses are provided on "The Calculation of Optical Systems," "Spectroscopy," "Glass: Its Nature and its Applications," "The Applications of Polarised Light," "The Microscope," and "The Properties of X- and γ-Rays." The fee for the session is 150 francs, and, although no one is excluded, it is pointed out that to profit as much as possible from the course students should have a fair knowledge of mathematics.

IN a paper published in the *Mathematical Gazette* for 1919–20 Dr. S. Brodetsky, reader in applied mathematics in the University of Leeds, brings forward a graphical treatment of differential equations as of special value in certain cases which are not soluble by the usual analytical methods and as of general value for purposes of instruction. There is justice in his view that the average student of mathematics regards the usual methods of solution as a series of tricks which he learns to apply with more or less success to such equations as are presented to him. A graphical treatment cannot fail to be of great value in teaching the meaning of differential equations and in giving the student confidence in their use. The paper contains numerous examples, and illustrates the meaning of singular solutions, cusp loci, etc. Not the least interesting example is the solution of the equation

$$\frac{dy}{dx} = -\frac{x}{y} - (x^2+y^2)^{\frac{1}{2}},$$

which occurred in discussing the motion of a plane lamina moving in air under the earth's attraction—one of the simple types of aeroplane motion. The equation was insoluble by any of the standard methods, but easily soluble graphically.

DURING the war considerable quantities of acetone were prepared by the fermentation of starchy material. Hitherto, however, no investigation of the mechanism of this fermentation has been described, and Messrs. J. Reilly, W. J. Higginbottom, F. R. Henley, and A. C. Thaysen publish in the April issue of the *Biochemical Journal* an account of a quantitative examination of the process. These authors find that the fermented mash contains varying proportions of acetic and butyric acids, the ratio of the latter to the former increasing with the increase (during fermentation) in the acidity of the mash and reaching a maximum at the stage of greatest acidity. Not until the latter stage is reached are appreciable quantities of acetone and *n*-butyl alcohol produced. With the production of "oil" the ratio of butyric to acetic acid diminishes, and finally the mash contains an excess of acetic acid. During the period of the increase of acidity of the mash the rate of gas evolution rises steadily for some time, then becomes constant; and as the acidity falls the rate of gas evolution rises quickly to a maximum, and then falls rapidly until the end of the fermentation. The gas consists of hydrogen and carbon dioxide in a proportion varying from 3 : 1 at first to 2 : 3 at the latter part of the fermentation. It is extremely probable that acetic and butyric acids are not the only acids formed, and evidence is given of the presence of an acid less volatile in steam. Lactic acid results from the type of infection most frequently observed. If the fermentation is carried out in the presence of calcium carbonate it proceeds as far as the point of maximum acidity, but the production of acetone and *n*-butyl alcohol is almost entirely suppressed.

IN the *Wiener Denkschriften* (Math.-Naturwiss. Kl., Bd. 96, pp. 671–750, 1919) Dr. A. Defant continues his important researches on tides in landlocked and border seas, bays, and channels. After a theoretical discussion of the influence of friction against the ocean-bed in channels, he deduces an average value of the coefficient of skin friction from a consideration of the tides in the Gulf of Suez and in certain lakes which exhibit seiches. He then enters upon a careful detailed study of the tides in the English Channel, using a step-by-step numerical method for the solution of the differential equations of the tides between successive cross-sections of the Channel. He thus succeeds in demonstrating the truth of a conjecture made long ago by Airy to the effect that the complicated tides of the Channel are governed mainly

by the definite tidal oscillations of the Atlantic Ocean and the North Sea at the two ends of the Channel; this view had been contested by Börgen, but the consequences of the view were misinterpreted by the latter. Dr. Defant shows that not only the co-tidal lines and tidal ranges, but also the phase and speed of the tidal currents in the Channel, can be explained on the basis of Airy's ideas, taking surface friction at the channel-bed into account, and also the rotation of the earth. He finds that the latter affords an explanation of why the tidal range on the French coast of the Channel is greater than that on the English coast. For the sections of the Channel near the east opening into the North Sea the calculations cannot be executed with the accuracy elsewhere obtained, owing to the approximation of the ocean-tidal period to the free period of lateral oscillation across this broad part of the Channel. But even here the chief features can be derived by interpolation, and throughout the remainder of the Channel all the important features of the complex Channel tides receive satisfactory theoretical explanation.

THE paper read by Gen. Squier to the U.S. National Academy on April 27 on "Multiplex Telephony and Telegraphy over Open-circuit Bare Wires Laid in the Earth or Sea" has excited great interest amongst radio-telegraphists, who find it difficult to make out whether we are on the eve of important developments or not. Gen. Squier has established communication for a distance of three-quarters of a mile over the Potomac River by means of a bare No. 12 phosphor-bronze wire laid directly in the water. The transmitter consisted of an electron tube oscillator, which produced a current of about 270 milliamperes at a frequency of 600,000. At the receiving end of the line an electron tube and a six-stage amplifier were used without any earth connection. With this arrangement good tuning could be obtained at either end of the line, and satisfactory telegraphic and telephonic transmissions secured by means of the bare wire immersed in fresh-water. In another experiment telegraphic and telephonic transmission were obtained between two stations three-quarters of a mile apart by means of a No. 16 copper wire buried in the earth to a depth of about 8 in. It will be seen that if the method develops satisfactorily it will have commercial possibilities. The best Atlantic cable cannot operate at a frequency greater than 10 per second, and 80 volts is the highest voltage that can be applied to work it. There is scope, therefore, for development in submarine telegraphy. Gen. Squier suggests that experiments should be made with bare wires in sea-water to determine what arrangement will give the best results. He points out that with this method there will be no distortion of the signals, and so there is no limit to the distance of transmission, and the receiving apparatus will be comparatively simple. It is also possible to transmit simultaneously several signals, both telephonic and telegraphic, over the same wire by using different frequencies. The method is an attractive one, and seems to have arrived at the stage where commercial research can usefully be started.

Our Astronomical Column.

PHOTOGRAPHS OF THE BRORSEN-METCALF COMET.—The *Astrophysical Journal* for March contains some photographs of this comet taken by Prof. Barnard on 1919 October 5, 6, 20, and 22. The tail is shown as fully 6° long, composed of several narrow straight streamers forming a fan. They radiate from a point somewhat behind the centre of the head. About October 20 the comet discarded its tail, and formed a new one inclined 12° to the old. Prof. Barnard notes that similar phenomena have been observed in Borrelly's comet, 1903 July 24, in Morehouse's comet on several dates in 1908, and in Halley's comet on 1910 June 6 (probably also in April).

In each case the new tail appears to move out faster than the rear portion of the old tail. Prof. Barnard conjectures that the latter is formed of larger particles, the motion of which would be slower.

He has combined successive cometary photographs in the stereoscope in the endeavour to determine the configuration of the tail in three dimensions. Care is, of course, required to distinguish true stereoscopic effects from spurious ones. It is stated that the tail of Morehouse's comet on October 15, 1908, resembled "part of an open sack, or a partly opened scroll."

THE PLANETARY FAMILIES OF COMETS.—The report of the nineteenth meeting of the American Astronomical Society contains a paper on this subject by Prof. H. N. Russell. He notes that the orbits of the six comets of the Neptune group all pass considerably closer to the orbits of Jupiter and Saturn than they do to that of Neptune. His first conclusion was that these comets had been captured not by Neptune, but by Jupiter. He analysed the orbits of the periodic comets with the following result:—

Thirty-six comets on his list have periods of less than ten years. The orbits of all these, except Encke's, pass within 0·65 of Jupiter's orbit, while seventeen of them pass within 0·15 of it.

Thirty-one comets have periods between ten and one thousand years. Of these, seven pass within 0·5 of Jupiter's orbit, five within the same distance from Saturn's orbit, and two within this distance from Uranus's orbit, the nearest approach to Neptune's orbit being 1·22.

Prof. Russell has calculated the proportion of the thirty-one comets that would pass within 0·5 of each orbit on the hypothesis of chance approach, and finds that it is six for Jupiter, three for Saturn, one and a half for Uranus, and one for Neptune. Hence he concludes that the observed figures give little evidence of capture by any of the planets.

There is, however, a point not noticed by Prof. Russell, which is that the periods under a century range themselves into four definite groups, the mean period of each group being about 0·4 of that of one of the giant planets. This gives strong ground for postulating a connection with these planets. Since Halley's comet has been observed for more than two thousand years, there is no difficulty in assigning to it a life dating back to the time when its orbit intersected that of Neptune. The longer the period of a comet the less frequent are the occasions when it is subject to serious disruptive influences, and consequently its disintegration is likely to be less rapid. It appears to the writer of this note that Proctor's suggestion that the periodic comets are the products of eruptions from the giant planets deserves more attention than it has generally received.

The Thunderstorms of May 29 and the Louth Disaster.

THE last week of May was marked by hot weather all over the country and by numerous thunderstorms, which culminated in the notable downpours of rain which occurred on Saturday, May 29. The highest temperatures were reported on Tuesday, May 25, when 82° F. was reached in London and the Thames Valley. In London the magnificent cumulus clouds made a fine spectacle, but it was further north, in the neighbourhood of Luton, that thunderstorms occurred. Paris suffered from a severe storm on the same day.

On Wednesday, May 26, when an area of comparatively low pressure extended across England and Ireland, there were thunderstorms in London and in other parts of the country during the afternoon. The rainfall in the west of London was exceptionally heavy. The area affected was somewhat sharply outlined on the west. At Hammersmith the roads were flooded and wood pavements burst up by the water, but at the Meteorological Office, a couple of miles away, only 2 mm. of rain fell. At Uxbridge 33 mm. fell in half an hour.

The distribution of pressure remained irregular, but lower over the British Isles than over neighbouring countries, and on Friday evening a "low," which appears to have originated over the South of France, began to deepen and to move northward. The map for 7h. G.M.T. on Saturday, May 29, indicates the depression by the isobar 1012·5 mb. over the Bristol Channel. At 13h. pressure was below 1012 mb. over the Midlands. By 18h. it had fallen to 1009 mb. in the same region. On Sunday morning the depression was over the North Sea, and by the evening, when it had deepened to 1004 mb., it was centred at the Shetlands.

The rainfall on May 29 was insignificant in the South of England, but falls of half an inch or more were general from Nottingham northwards. The exceptional falls in Lincolnshire and Lancashire occurred before the northward passage of the trough of lowest pressure. As to the downpour in Lincolnshire, to which the damage and loss of life at Louth are to be attributed, records are available from Hallington, in the valley west-south-west of the town, and from Elkington Hall, on the hills to the north-west. In each case the measurement was about 120 mm. in two hours, giving a mean rate of fall of 1 mm. per minute. According to newspaper reports, 100 mm. fell at Horncastle, twelve miles south-south-west of Louth.

The area with an exceptionally heavy rainfall included Bucknall, sixteen miles south-west of Louth, with a total fall of 54 mm.; at Lincoln, twenty-four miles away, the fall was 52 mm.; and at Spurn Head, to the north, it was 35 mm. The boundary of the area of heavy rain is marked by 34 mm. at Cranwell and 12 mm. at Fulbeck, these places being about four miles apart on either side of the Ermine Street, south of Lincoln. At Skegness only 12 mm. fell. There were two thunderstorms in the afternoon, both carried westward by the wind on the north side of the cyclone. One was at Skegness at 13.15 G.M.T., and at Lincoln at 14.30. The other, which was the more severe, moved more slowly, passing Skegness at 16h. and Lincoln between 18.30 and 19h.

The Louth disaster seems to have been associated with the former storm. From the evidence at the inquest of a witness from Benniworth, a village on the far side of the Wolds, in the Bain Valley, it appears that after a little rain between 12h. and 14.15 the weather cleared, but that at 14.30 the rain suddenly poured so fast that the house-pipe could not carry it. "In a moment the fields were at least 8 in. deep in water. I saw a huge cloud in the shape of an egg which kept twisting round. There were three flashes of lightning, very vivid and very shocking. One seemed to pierce through the cloud, and immediately afterwards the cloud seemed to come earthward."

Examination of the ground by the deputy coroner indicated that the heavier rainfall had been on the north side of the line from Louth to Lincoln, and that it was more severe higher up the valley than at Hallington, where the rain-gauge, which measured 120 mm., was situated. It is likely that the 120 mm. is a fair average for the fall over the basin of the Lud above Louth. This basin contains three or four brooks which unite above the town and drain an area of about 20,000 acres. The Wolds are chalk hills, however, and no doubt the greater part of the normal drainage is underground. This may account for the absence of any provision for the passage of flood-water, but much of the ground slopes at about 100 ft. to the mile, so that water would run off rapidly. Rainfall at the rate of 1 mm. per minute over an area of 80 sq. km. would feed a stream 5 metres deep and 100 metres wide rushing along at 160 metres a minute, and the Lud does not appear to have reached such a magnitude as this. The town seems to have been singularly fortunate in escaping floods in the past, as a rainfall of even one-quarter of that on the present occasion could scarcely have found its way through the narrow bridges of the town.

With regard to the heavy falls in Lancashire, we are so fortunate as to have the autographic record from the rain-gauge at Leyland, to the south of Preston. The total fall for the twenty-four hours, 9h.–9h. May 30–31, is about 80 mm., "the like of which the proverbial oldest inhabitant cannot remember." The heaviest downpours were from 16.30 to 17h. and from 17.55 to 18.15. In the latter interval of twenty minutes no less than 40 mm. were recorded. The more dramatic exploits of the flood-water due to this storm appear to have been to the north of Preston, where the main line of the London and North-Western Railway was interrupted by the destruction of the embankment near the crossing of the River Brock. In spite of the long duration of the rain at Preston the fall at Blackpool, fifteen miles to the west, amounted to only 5 mm. in the twenty-four hours.

Annual Meeting of the British Science Guild.

THE annual meeting of the British Science Guild was held in the Goldsmiths' Hall on Tuesday, June 8, the chair being taken by Lord Sydenham, president of the guild.

In his address on "Science and the Nation" the president referred to the strike evil as one of the great industrial problems of the day. The moulders' strike had seriously affected many industries; loss in coal had reached 50,000,000 tons a year as compared with 1913, with serious consequences to the export trade. The evil was due partly to an abnormal state of mind arising from the war, but was originally fostered by the industrial changes of the last century, namely, the general use of machinery, rendering labour monotonous and leaving less room for the individual skill of the craftsman, and the formation of large companies, whereby the personal touch between master and man was lost. Capital unduly concentrated in a few hands might lead to tyranny. This country needed a wider distribution of capital. Labour and capital must be reconciled, and science must find an

antidote for the deadening influence of the machine. In the latter portion of his address Lord Sydenham emphasised the importance of a more general knowledge of science, especially amongst members of the Government and the Civil Service, and alluded to the efforts made by the Guild in the dissemination of scientific knowledge and methods. He concluded by quoting Goethe's saying that "there is no more dreadful sight than ignorance in action."

Lord Sydenham then introduced the president-elect, Lord Montagu of Beaulieu, who delivered an address on "Some National Aspects of Transport," and afterwards occupied the chair. Lord Montagu remarked upon the growing difficulties of railways, which, although subsidised by the State, were working with a diminishing margin of profit owing to the vast increases in cost of materials and in wages. Some of the largest tramway systems, such as the L.C.C. in London, were incurring actual loss, and a general increase in fares and rates seemed inevitable. Some economies might be achieved by more scientific methods of handling traffic and the elimination of competition, but the saving from this source appeared relatively small. The possibilities of road transport, therefore, assumed importance. Already the comparative cheapness of short-distance road-borne traffic had deprived the railways of much revenue. Existing roads, however, were unfitted to bear very heavy mechanical traffic. On a tar-macadam road the tractive force was 40–45 lb. per ton, three times the force on rails, and on bad roads up to 100 lb. per ton may be needed. In the pre-railway period roads carrying metal tracks 2 ft. wide were constructed for carts carrying coal, minerals, etc. It might be feasible to lay such a plateway from London to Birmingham with a tractive force of only 20 lb. per ton. The cost of a double track would be about the same as for a single line of railway, as gradients up to 30:1 could be used. The cost of operation would be on a smaller scale than on railways, and goods could be delivered direct from door to door. The idea could be extended to other large towns, and it was conceivable that overhead roadways, for the exclusive use of fast-running vehicles, might be made from the suburbs. The creation of such routes would lead to a material increase in the value of property through which they passed, and part of the cost might be met by a local transport benefit tax, applied in such cases.

Lord Montagu also referred briefly to other possible developments, such as the use of the airship for long distances and aeroplanes for shorter services, and the possible use of gas suction plant for propelling locomotives, motor-lorries, and ships, and of benzol and alcohol in the internal-combustion engine.

In view of the national importance of these problems, the creation of a chair of transport at one of the leading universities would be a deserving object for private beneficence. The two Institutions of Civil Engineers and Mechanical Engineers should be more frequently consulted by the Government in regard to road transport, and the National Physical Laboratory had done excellent work. The problem, however, was so vast as to demand continuous research at a special establishment.

The adoption of the annual report of the Executive Committee was proposed by Lord Bledisloe, and seconded by Sir Gilbert Parker, both of whom are vice-presidents of the Guild. A cordial tribute was paid to the valuable services Lord Sydenham had rendered to the Guild during his tenure of office, and both speakers expressed the general appreciation of Lord Montagu's acceptance of office as the new president.

The report, summarised by Lord Bledisloe, dealt with various aspects of the work of the Guild. The second British Scientific Products Exhibition, held in 1919, was honoured by a visit from both King George and Queen Mary, accompanied by Prince Henry and Princess Mary, and demonstrated the growing appreciation by British manufacturers of the value of applied science. During the present year it is hoped to arrange a conference on science and labour in association with the Labour Party. A representative committee is being set up to collect full data on the utilisation of science, not only in the Civil Services, but also in all Government Departments, and the Parliamentary Committee, which has already intervened with good effect in the Forestry Bill, will watch all prospective legislation involving scientific and technical issues. The Education Committee of the Guild is still pressing for a real survey of the existing provision of university and higher technical education in the country, considering that the new Standing Committee on University Grants, acting under the Board of Education, is inadequate as regards composition and reference. The revised specifications of the Technical Optics Committee in regard to microscopes have already been adopted by two British firms.

The adoption of the report having been carried unanimously, the proceedings were terminated by a vote of thanks to the Master and Wardens of the Goldsmiths' Company for permission to hold the meeting in their hall.

Annual Visitation of the Royal Observatory, Greenwich.

DURING the war this annual function was restricted to the official visit of the members of the Board. It has now returned to the conditions that prevailed many years ago, a large and representative gathering of astronomers and their friends being present on Saturday, June 5, to take part in the inspection of the observatory and instruments.

The return of many members of the staff who had been at the Front has naturally brought about a large increase in the number of observations. Those made with the transit circle exceed eight thousand in each element. In addition to the customary observations of sun, moon, planets, and clock-stars, the observing list now includes the stars selected by Backlund and Hough as secondary standards distributed with fair uniformity over the sky. Observations for this catalogue will be completed at the end of 1921.

The error of the moon's place in longitude for 1919, as predicted in the Nautical Almanac, was $-12{\cdot}26''$, showing a notable diminution of nearly $2''$ from the value for the three preceding years. The Astronomer Royal explains that this change is due to the omission in Hansen's tables of several sensible planetary terms. In view of the imperfections of these tables, it is satisfactory to note that Brown's new lunar tables have now been printed and are used in the Nautical Almanac, starting with the year 1923.

Two of the equatorials are now out of use. The 28-in., the mounting of which dates from 1851, requires renewal of the upper pivot; this work has been entrusted to Messrs. T. Cooke and Sons. The driving clock of the astrographic equatorial was sent to Sir H. Grubb for repairs, which are still in progress. The observations of double-stars made with the 28-in. since its erection have been discussed by Mr. Jackson, who has published more than twenty new orbits in the Monthly Notices for March and April last. Fuller details of these and other systems will be printed in the Greenwich annual volumes. There are many systems for which orbits cannot yet be deduced, but where relative motion is shown; hypo-

thetical parallaxes are being deduced in these cases, recent research having proved that such parallaxes are of considerable value for statistical purposes; they are, indeed, as trustworthy as those directly measured when the latter are of the order of 0·02″.

The photographic determination of parallaxes with the 26-in. photographic equatorial has been resumed, and twenty new parallaxes have been determined with an average probable error of 0·008″. It is anticipated that in future forty new parallaxes will be determined annually. The plan adopted for the measurement of the star images on the eclipse plates (that is, the preparation of a key plate with reversed images, which is placed film to film with the plates to be measured) is now being adopted for the parallax plates. Instead of producing the key plate by photography, short lines will be ruled on a glass plate in a north-and-south direction corresponding with the positions of the stars on each set of parallax plates.

A few photometry plates of the Kapteyn selected areas in N. decl. 30° have also been taken.

Two Star Catalogues are in process of being printed, viz. the zone catalogue of stars down to the 9th magnitude in N. decl. 24° to 32°, and the proper-motion catalogue of stars near the North Pole (vol. iii. of the Greenwich Astrographic Catalogue).

The proper motions of the stars in both these catalogues have already been discussed in several papers in the Monthly Notices.

The reduction of the solar photographs fell into arrears owing to the impossibility of transmitting plates from India and the Cape to fill the gaps in the Greenwich series. Work is now being pushed on as rapidly as possible, and has been brought up to the middle of 1917. There were considerable solar outbursts in August and March last, both accompanied by magnetic storms, but the general spot activity is now on the decline.

The Astronomer Royal makes allusion in his report to the successful result of the eclipse expeditions of 1919. Transparencies from the plates secured then were on view, and showed both the star images and the splendid prominence 300,000 miles in length which was on the sun's eastern limb.

It is proposed to repeat the investigation of the star-shift at the eclipse of 1922 September 20. According to present plans, Messrs. Jones and Melotte will observe it from Christmas Island, Indian Ocean. They will use the astrographic, mounted equatorially, discarding the cœlostat, which is a source of trouble in work where great refinement is needed. Plans have been mooted for utilising the presence of the instrument in low latitudes to take a series of plates with the view of linking together the northern and southern magnitude scales.

The mean magnetic declination for 1919 is 14° 18·2′; it is diminishing about 0·6′ annually, so that it should reach zero about the end of the century.

As regards the weather of the twelve months ended on April 30 last, it is interesting to note that the period October–November was the coldest for eighty years, while the period December–April was the warmest for eighty years. This accounts for the exceptionally early appearance of the blossoms, which was three weeks in advance of the average.

The daily sunshine register has been supplemented since last January by a small fixed camera pointing to the pole, which records trails of circumpolar stars throughout the night, forming a gauge of the clearness of the sky.

The reception of wireless time-signals from Paris, Nauen, Lyons, and Annapolis now forms part of the daily routine. The times of their reception will be printed in the Greenwich volumes, and will be available for longitude determinations. It has lately been announced that the Lyons signals can be read at Adelaide, so that it is hoped that improved values of the Australian longitudes will shortly be available.

The Astronomer Royal notes the loss that the observatory has sustained in the recent retirement of Messrs. Maunder, Thackeray, and Hollis, and expresses warm appreciation of their long and zealous services.

Applied Statistics.

IT is only twenty-five years since Prof. Karl Pearson gave at University College, London, his first course of lectures on the mathematical theory of statistics, and the opening at University College, London, on Friday, June 4, of the handsome building provided by the generosity of Sir Herbert Bartlett, Bart., for the Department of Applied Statistics, including the Galton Laboratory and the Drapers' Company Biometric Laboratory, marks another stage in the progress of what is more than a new branch of science, for there is scarcely a single field of scientific work in which the fundamental importance of the methods of research which have been developed by Prof. Pearson and his pupils has not been recognised.

The Drapers' Company in 1902 was the first to provide funds to carry on research work in what was then known as the Biometric Laboratory, and is now appropriately called the Drapers' Company Laboratory, and its annual grants have been continued up to the present time; while nine years later Sir Francis Galton bequeathed the residue of his estate to the University of London for the establishment of the Galton professorship of eugenics. Sir Francis expressed the wish, however, that so far as possible the capital of the endowment should be preserved intact, and the University accordingly issued an appeal for the building and equipment of a Francis Galton laboratory. Immediately afterwards Sir Herbert Bartlett offered to provide a building for both the Galton and Biometric Laboratories.

The building was nearly ready for occupation when, on the outbreak of war, not only had it to be given up for use as a military hospital, but also the voluntary services of the staff of the laboratories were offered to and accepted by the Government. In the early days of the war hundreds of diagrams were prepared weekly of the extent of unemployment in all the important towns of Great Britain, and when unemployment ceased to be a serious problem the laboratories were engaged in statistical inquiries into the seasonal use of shipping and rates of exchange and in investigations into aeroplane propeller stresses and ballistics. The computation of sights for various types of machine-guns to be used against low-flying German aeroplanes was carried out by very strenuous and continuous labour in six weeks.

One result of the delay in completing the equipment of the building is that funds which were insufficient in 1914 are now wholly inadequate, and this splendid building can only be partly used. Equally essential is the provision of funds for the salaries of the staff, and it is estimated that to complete and maintain the equipment of the new building and to carry on and develop the work of the laboratories in accordance with the intentions of its founders there is required an additional income of 5000*l*. a year. The Senate of the University of London has accordingly authorised an appeal for this endowment.

At the opening ceremony, at which Dr. Russell Wells, the Vice-Chancellor of the University of London, presided, Dr. Addison, Minister of Health, said that his work in the Ministry of Munitions had

been hindered by the constant struggles to find out what we had and what we wanted, and it was only when they obtained the services of trustworthy statisticians that the Department got into clear order. In the field of public health trustworthy statistics were of equal importance, and he therefore recommended to the public the appeal which had been made for additional funds, and promised to do all he could to help on the work of the laboratories. D. H.

The Imperial College.

CLAIM TO UNIVERSITY STATUS.

A MEETING in support of the claim of the Imperial College of Science and Technology for power to confer degrees and for university status was held at the Central Hall, Westminster, on Friday, June 4. Lord Morris, who presided, stated that the meeting was not called in hostility to any university or Government Department, or in disparagement of the atmosphere created by the universities. The governing body, the professorial staff, and the students, now numbering 1300, were unanimous in support of the claim of the Imperial College for power to confer degrees in its own subjects or faculties. The students were seriously handicapped by having to go to an external body for a degree, because of the current preference in the industrial and professional worlds for a degree to a diploma. Lord Morris moved a resolution urging the Prime Minister, the Lord President of the Council, and the President of the Board of Education to take the matter into serious consideration. The resolution also declared that any further delay would cause a growing sense of injustice.

Prof. W. W. Watts, who seconded the motion, pointed out that the report of the Departmental Committee, the recommendations of which in 1906 led directly to the establishment of the Imperial College, was based on a vision of a vast technological and Imperial institution, not confined to mere technical instruction, but devoted to the highest education and training in research in both pure science and technology. The Departmental Committee had stated clearly the reasons against incorporating the Imperial College in the University of London, pointing out that if the college was to be able to adapt itself to the ever-changing conditions of industry it must be free from the academic trammels of an education regulated, and rightly regulated, by other aims.

Mr. H. G. Wells, speaking in support of the motion, warned the meeting that in approaching the Lord President of the Council and the President of the Board of Education the delegates would have to combat the suspicion that their proposal involved a system of education and training likely to turn out men and women of narrow culture, mere technical experts without broad views. The curse of education in London had been the grandiose ideas of people who could not distinguish between the Universities of Oxford and Cambridge and the university conditions of London. It was almost impossible to conceive the widely separated college units in London co-operating successfully to form a single efficient university.

Sir Ernest Rutherford, speaking as a representative on the governing body of the Imperial College of the Dominion of New Zealand, said it was not generally recognised how much energy is spent in developing the pure science side of the Imperial College. It was only right and proper that the students, and particularly the oversea students, should have a degree where degree-work had been done, and the degree should be conferred by the teachers, and not by any outside body. Surely we might broaden our ideas of university education in general. We had never before had an institution teaching technology on such a vast scale and to such a high standard as the Imperial College does. There was no precedent for the college, and therefore there could be no precedent against its claim to confer its own degrees. Subsequent speakers included Mr. J. A. Spender, Sir Richard Redmayne, and the Rector of the Imperial College, Sir Alfred Keogh. The resolution, modified slightly in accordance with suggestions made by Mr. H. G. Wells and others, was carried with one dissentient.

The Smoke Nuisance.

THE Manchester City Council is one of the few local authorities which have gone out of their way not only to put the smoke clauses of the old Public Health Act into force, but also to investigate the cost to the community of the smoke nuisance. With true wisdom it has realised that the æsthetic sense of the average man is controlled by his pocket, and that the direct road to reform is to make him understand how much he might save by a clean atmosphere.

We have received from the Air Pollution Advisory Board of the Manchester City Council a pamphlet entitled "The Black Smoke Tax," and although it deals mainly with an elaborate investigation into the relative cost in fuel, soap, and starch in an industrial and a residential centre, there is an introduction which reviews in brief but expressive language other causes of loss and damage which follow in the train of black smoke. The Board says:—"The damage is both æsthetic and economic. The look of things suffers. The value of things suffers. Everybody suffers and, since everybody suffers, it is a long time before anybody protests. If the damage were done suddenly there would be a general outcry, but it is done gradually. Thousands of Manchester people live their lives from start to finish in the midst of black smoke and have come to regard it as a normal condition of life. It is only in modern times that we have realised that the nuisance is preventable and that public economy, public health, and happiness alike call for its prevention."

The investigation has been conducted on the lines adopted in Pittsburgh, U.S.A., which showed an annual loss amounting to 4*l.* a head of the population. A large number of different classes of houses in Manchester (industrial) and Harrogate (residential) were personally visited and the weekly washing bill as nearly as possible ascertained. The net result was an additional expenditure in Manchester of more than 242,000*l.* annually on this item alone. The committee employed on this investigation concludes its report as follows: "As a result of years of patient investigation, coupled with strict rejection of all doubtful evidence, they can state emphatically that it would well repay Manchester to expend a large amount of thought and money on any measures that would help to reduce its enormous yearly smoke tax of at least three-quarters of a million pounds per annum."

The Ministry of Health has now taken the matter in hand and appointed a Smoke Abatement Committee to consider ways and means of abolishing smoke. The report of this committee will no doubt contain recommendations which will give local authorities greater facilities and stronger inducements for dealing with this pest of industrial towns. Coal smoke is opposed to every principle of economy, health, comfort, and cleanliness. It is a national scourge which has been too long tolerated.

J. B. C.

The Molecular Energy in Gases.

BY request of the council of the Royal Society of Edinburgh, an address on "Molecular Energy in Gases" was delivered on May 3 by Principal Sir Alfred Ewing, who began by referring to a series of papers on the foundations of the kinetic theory which were communicated to the society thirty years ago by a great teacher and a great master of the subject, Prof. Tait. Since those days the kinetic theory had received what might be called ocular demonstration through Perrin's investigation of the Brownian movements, which exhibited the buffeting of visible bodies by the blows of the molecules. Much had come to be known regarding the probable structure of the atom. There had been substantial advances in the study of specific heats of gases and of their absorption and emission of heat in the form of infra-red rays. But the difficulty referred to by Tait of reconciling the known facts about specific heat with the theory of the equipartition of energy, as developed by Maxwell and Boltzmann, still remained, and had led to various applications or extensions of Planck's quantum theory, not only to the vibrations of gaseous molecules, but also to their rotations.

Some of these applications of the quantum theory appeared to the lecturer to be highly artificial, and also unnecessary. He proceeded to discuss the correspondence between the observed values of the specific heats and those that might be expected by applying ordinary dynamics to the translations and rotations of the molecules of a gas, and pointed out that the results presented a consistent scheme, which had, however, to be supplemented by taking account of the energy of vibration, especially at high temperatures. Vibratory energy became developed in a manner which was clearly not consistent with the principle of equipartition. It was now known that in all except monatomic gases the specific heat became notably increased at high temperatures, when the vibrations within the molecules began to be an important part of the whole energy. The experimental facts as to this increase were no doubt well expressed by means of Planck's quantum formula, but the type of curve which it gave was one that was found in other departments of physics. It was therefore open to question whether, if the nature of the constraints were understood, the development of vibratory energy in the molecules might not be interpreted in terms of other ideas than those of quanta, and without disturbing the old-fashioned principles of Newtonian dynamics.

University and Educational Intelligence.

BIRMINGHAM.—In common with other universities, that of Birmingham has been overcrowded with students during the past session, and, in order that the necessary arrangements may be made to accommodate the maximum number for the ensuing year, public notice has been given that intending students should make application for entry not later than June 30. Already temporary buildings are being erected to cope with the certain increase in number of second-year students. The problem of adapting the number to be admitted to the available accommodation is undoubtedly difficult, but any method of restriction adopted will be devised with the object of securing admission to the fittest.

CAMBRIDGE.—Announcement is made in the *Times* that the directors of the Commercial Union Assurance Co. have allotted the sum of 165,000*l.* for a building of biochemistry, on a site provided by the University, for the provision of adequate incomes for the professor and his staff and for the endowment of research.

LIVERPOOL.—At a meeting of the Senate of the University held on June 2 the following resolution was passed: "The Senate records with profound regret the death of Prof. Leonard Doncaster, F.R.S., Derby professor of zoology in the University. But a short time in Liverpool, Prof. Doncaster had taken a prominent place in the University, serving on the University Council as representative of his faculty, and had added to the reputation of the University by his contributions to science, and notably by his text-book upon cytology, published within the last few weeks. As colleague and friend he will be mourned by all members of the University. To Mrs. Doncaster and the members of his family the Senate would offer its most sincere sympathy."

THE Ramsay Memorial Trustees will proceed to the election of not more than three fellows at the end of this month. Applications must be received not later than June 15. Application forms, containing full particulars of the award, can be obtained from the Organising Secretary of the Ramsay Memorial Fund, University College, London. The fellowships are of the value of 300*l.* a year each, and tenable for two years. They are for the advancement of chemical research.

THE annual vacation course in Snowdonia for field-work in geography, geology, botany, map-making, and regional survey methods is being held under the auspices of the Geographical Association on August 7–21, with Llanberis as a centre. Particulars of the arrangements may be obtained by sending a stamped addressed envelope to Mr. H. Valentine Davis, "Noddfa," Wistaston, Crewe. The course is primarily intended for teachers of geography in public and other secondary schools.

LORD ERNLE presided at a meeting held last week at Chelsea House, Cadogan Square, to establish the training of women as skilled scientific cultivators on a national basis. In recognition of the magnificent work achieved, especially during the war, by Swanley Horticultural College in increasing every class of home-grown foods, and also in food preservation, the Ministry of Agriculture proposes to allot a Treasury grant of 10,000*l.* for the re-equipment and further development of this unique training college, provided the public contributes an equal sum. Never has the national need for scientific food production on one hand, and for remunerative and healthy employment for educated women on the other, been greater. Swanley has full capacities for carrying out both these works of national importance once the ravages of five years of war-shortages have been repaired, and the urgently needed new laboratories, lecture-rooms, library, and students' hostels have been erected and equipped. The great demand for women workers in agriculture and horticulture is proved by the fact that the applications from employers for Swanley students rose from 130 in 1914 to 648 in 1918. Prof. Keeble, of Oxford University, pointed out that the future cultivation of England would become more and more intensive, and that this intensive cultivation is now of the greatest national value, significance, and economic justification. Plans for the new science buildings at Swanley are now ready and the site is selected. It only remains for the public to provide the 10,000*l.* required to secure the Treasury grant for this urgent work of national utility. The appeal recently issued is signed by Lord Ernle, late President of the Board of Agriculture and Fisheries; Lord Lambourne,

president of the Royal Horticultural Society; Prof. J. Bretland Farmer; Prof. Keeble; Lady Northcliffe; and Viscountess Falmouth, chairman of the governing body, Swanley College. Donations may be sent to Messrs. Child and Co., 1 Fleet Street, London, E.C.4. Ten thousand pounds is needed at once, and 50,000l. for the complete installation of the science department and for the reconstruction of the college and of the intensive training grounds.

Societies and Academies.

LONDON.

Physical Society, May 14.—Sir W. H. Bragg, president, in the chair.—Dr. F. Lloyd **Hopwood**: Experiments on the thermionic properties of hot filaments. The experiments shown were some of those described by Dr. Hopwood in the *Philosophical Magazine* for March, 1915, p. 362, in which the glowing filament of a carbon lamp and glowing filaments of nichrome and platinum in air are made to move under the influence of positively and negatively charged rods brought into or withdrawn from their vicinity, the character of the effects observed being such as to give a qualitative indication of the thermionic emission from the filaments. In addition, he showed a type of tilted electroscope in which the gold-leaf was replaced by a narrow loop of Wollaston wire. When a current is passed through the wire so as to make it glow, it forms an electroscope of different sensitivity for +ve and −ve charges.—G. D. **West**: A modified theory of the Crookes radiometer. The paper gives a short account of a theory of the Crookes radiometer worked out by Sutherland in 1896, but, unfortunately, much neglected. The theory as it stands will not explain many radiometric phenomena, but it is shown that when modifications depending on the modern knowledge of thermal surface conditions are made, such explanations become possible. Radiometer action, especially at the higher gas pressures, would appear to depend essentially on the formation of gas currents near the radiometer vane. These currents are distinct from convection currents, but are closely associated with the phenomena of thermal transpiration.—A. **Campbell**: The magnetic properties of silicon iron (stalloy) in alternating magnetic fields of low value. Measurements are described of the hysteresis losses in silicon iron sheet and wires in very low alternating magnetic fields at low and telephonic frequencies, using an alternating-current method described in a former paper. The equations giving the hysteresis losses as a function of $B_{max.}$ are deduced in the case of the sheet material at low frequencies for ranges of $H_{max.}$ from 0·0002 to 0·02. Comparisons are made between sheet material and wires of different diameters, and curves are given showing the great improvement in the permeability of wires when they are annealed. The behaviour of the material is studied, both by ballistic tests and at telephonic frequencies, as regards the alternating field when direct-current fields of various values are applied at the same time.—T. **Smith**: Tracing rays through an optical system. Equations for tracing rays in an axial plane through an optical system have the normal refraction terms separated from those representing aberrations. By expressing the latter as a fraction with the first-order aberration as the numerator and a correcting factor, which may take various forms, as the denominator, rays may be traced exactly through the system, using a short table of cosines in terms of sines in place of the extensive tables, giving sines in terms of angles generally employed. A considerable saving of time is effected in the calculations, and the estimation, without calculation, of the aberrations of other rays is facilitated.

Geological Society, May 19.—Mr. R. D. Oldham, president, in the chair.—Dr. H. H. **Thomas**, with chemical analyses by E. G. **Radley**: Certain xenolithic Tertiary minor intrusions in the Island of Mull (Argyllshire). The paper deals with a series of minor intrusions, generally tholeiitic but occasionally composite in character, which are well represented in the western peninsula of Mull, lying between Loch Scridain and Loch Buie, and are remarkable for the number and mineralogical peculiarities of the xenoliths that they contain. Xenoliths of a highly siliceous nature (quartzites, sandstones, etc.) are met with, but more commonly the inclusions are of a type rich in alumina (shales and clays). Cognate xenoliths of noritic and gabbroic affinities occur in several of the intrusions, and these, together with the accidental siliceous xenoliths, are briefly described; but the communication deals more particularly with the aluminous inclusions which are crowded together in most of the intrusions, range up to several feet in diameter, and are characterised by well-crystallised minerals such as sapphire, spinel, sillimanite, cordierite, and anorthite. These xenoliths offer the clearest evidence of the modification of a more or less pure aluminous sediment by permeation of magmatic matter, more particularly by the diffusion of lime, ferrous iron, and magnesia. It is held from the evidence afforded by the xenoliths that the metamorphism is of a deep-seated character, and has been effected by a tholeiitic magma on the walls of its basin, which were composed mainly of aluminous sedimentary rocks.

CAMBRIDGE.

Philosophical Society, May 3.—Sir Ernest Rutherford, vice-president, in the chair.—W. J. **Harrison**: Notes on the theory of vibrations. (1) Vibrations of finite amplitude. (2) A theorem due to Routh. Rayleigh determined, in trigonometric form, the approximate effect of small terms varying as the square and cube of the displacement in the equation of simple harmonic motion. In the former of these notes exact Fourier series are determined by the theory of elliptic functions, and tables are computed. The latter note relates to the theorem that an increase of inertia of any part of a vibrating system increases all the periods in such a way that the new periods are separated by the original periods. If the effect of the increased inertia be represented by an addition to the kinetic energy of the square of a linear function of the velocities, it is pointed out that the theorem does not hold unless this linear function involves all the velocities.—W. **Burnside**: On cyclical octosection. The complete solution of the problem of cyclical quartisection was first given by V. A. Le Besgue in *Comptes rendus*, vol. li., 1860, without proof; he forms the quartic equation satisfied by the sum of $\frac{1}{4}(p-1)$ distinct primitive pth roots of unity, p being a prime number of the form $4n+1$. If $p=L^2+4M^2$, where $L\equiv 1 \pmod 4$, the equation involves p and L, being

$$\{y^2+p[2(-1)^{\frac{p-1}{4}}-1]\}^2=4p\{y-L\}^2,$$

where y is one more than four times the sum in question. The only proof as yet published appears unnecessarily long. The present paper deals with the case when p is a prime of the form $8n+1$; it forms and solves the equation satisfied by the sum of $\frac{1}{8}(p-1)$ distinct primitive p roots of unity, which is capable of eight values, by a method capable of extended application. Expressing p in both the forms a^2+b^2, $a'^2+2b'^2$, this equation involves p, a, and a'.—Dr. G. F. C. **Searle**: (1) A bifilar method of measuring the rigidity of wires. The upper ends A, C of two equal

wires are attached to two torsion heads, and the lower ends B, D to a bar loaded with a considerable mass. When the wires are free from torsion, they are in a vertical plane. The distances $AC=2a_1$, $BD=2a_2$, are nearly equal. If the torsion heads are turned through ϕ from their zeros, the bar will turn through θ in the same direction, until the bifilar couple balances the couple due to the torsion of the wires. Then $\sin\theta=C(\phi-\theta)$, where C is, for practical purposes, independent of ϕ and θ. By observing θ and ϕ, C is found. Then, if r is the mean radius of the wires and M the load supported by them, the rigidity, n, is given by

$$n=\frac{g a_1 a_2}{\pi r^4}\,.\,MC.$$

A damping device is provided so that steady readings can be obtained in a room subject to vibration. Bends in the wires near the upper ends have the same effect as if the points A, C described small horizontal circles. Errors due to this cause are eliminated by a rough harmonic analysis. (2) An experiment on a piece of common string. When a mass M is suspended by a piece of common string from a fixed support, it begins, when set free, to rotate about the axis of the string. The string, therefore, exerts a couple, G, on the body, and the relation of this couple to M is studied in the experiment. If, starting from rest, the body makes n revolutions in time t, the angular acceleration α, assumed constant, is given by $\frac{1}{2}\alpha t^2=2\pi n$. If K is the moment of inertia of the body, $G=K\alpha$. If the length of the string is of the order of 2 metres, the angular acceleration is approximately uniform for at least the first 10 or 20 revolutions. The load is supplied in the form of a number of equal inertia bars which can be threaded on a light rod carried by the string. Then K is practically proportional to M. It is found that the time for, say, 10 revolutions from rest is nearly constant. Hence G is nearly proportional to M. (3) Experiments with a plane diffraction grating, using convergent light. A lens forms a real image B of a vertical slit S illuminated by sodium light. A plane diffraction grating, with its rulings vertical, is placed between the lens and B, so that the vertical central plane of the beam, which cuts the grating in O, makes an angle θ with the normal to the grating, and $BO=u$. If C is one of the "real" diffracted images of order p, and if CO or v makes an angle ϕ with the normal, then

$$u\sec^2\theta=v\sec^2\phi \quad . \quad . \quad . \quad . \quad (1)$$

If the grating interval is d, the wave-length is given by

$$p\lambda=d(\sin\phi-\sin\theta) \quad . \quad . \quad . \quad . \quad (2)$$

In the experiment the relation (1) is tested, and the wave-length is found by (2). The images are received on a glass scale moving along an optical bench, the length of the scale being horizontal and perpendicular to the bench.—Major P. A. **MacMahon**: Congruences with respect to composite moduli. This paper deals with the primitive roots of the binomial congruence the exponent of which is any divisor of the totient of a composite modulus. Numbers being divided into categories according to the number of their different prime divisors, tables of primitive roots are given for the cases of the second and third categories.—A. **Kienast**: Equivalence of different mean values. This is a continuation of a former paper by the author, and deals with the equivalence of conditions for the existence of the limit of the mean sum of a continually increasing number of terms.—Prof. H. F. **Baker**: Construction of the ninth intersection of two cubic curves passing through eight given coplanar points. Let A, B, C, M, N and P, Q, R be the given points; take T external to their plane; let TP, TQ, TR meet a quadric containing A, B, C and the lines TM, TN, in further points P′, Q′, R′; let the twisted cubic curve through T, A, P′, Q′, R′ which has BC for chord meet the quadric again in O′; then TO passes through the required ninth point.—W. E. H. **Berwick**: Quintic transformations and singular invariants. This paper deals with the arithmetical solution of a certain sextic equation arising in the theory of modular functions, the coefficients of which are functions of a certain algebraical number. The arithmetical character of the number of fields which arise is determined in detail.

MANCHESTER.

Literary and Philosophical Society, May 4.—Mr. William Thomson, vice-president, in the chair.—Major T. **Cherry**: The origin of agriculture. The annual flood-cycle of the Nile provided perfect conditions for the growth of cereals. Since none other of the great rivers on the banks of which civilisation first appeared afforded such natural possibilities for the growth of cereals, it was claimed that man must have learned in Egypt irrigation and the cultivation of cereals. The author, in discussing the origins of wheat and barley, claimed that the originals of our cultivated barley probably evolved in the Nile Valley, and those of our wheat on one of the islands of the Ægean Archipelago.

Literary and Philosophical Society (Chemical Section), April 30.—Mr. J. H. Lester, chairman, in the chair.—Dr. J. A. R. **Henderson**: Alchemy and chemistry among the Chinese. The early objects of the alchemists were discussed, and their discoveries in metallurgy, mineralogy, and botany detailed. The latter included the manufacture of pigments, lacquers, porcelain, paper, and the early discovery of the explosive properties of gunpowder. The exploitation of vast coal deposits and of iron and other metallic ores, and the production of oils and medicinal substances, are taking place.

May 14.—Mr. J. H. Lester, chairman, in the chair.—Prof. F. L. **Pyman**: The relation between chemical constitution and physiological action.

DUBLIN.

Royal Irish Academy, May 10.—The Most Rev. the Right Hon. J. H. Bernard, president, in the chair.—J. N. **Halbert**: Acarina of the Intertidal Zone. The various forms, several of which are new to science, were studied in their relation to the well-known zones, or belts, of the orange lichen, Pelvelia, and Fucus usually present, where there is sufficient foothold for them, on the sea-shore. Excluding the families Halacaridæ and Hydrachnidæ, the species are distributed in the four terrestrial families as follows: Gamasidæ 28, Oribatidæ 17, Tyroglyphidæ 2, and Trombidiidæ 18.—Miss Jane **Stephens**: The freshwater sponges of Ireland. The fresh-water sponges of Ireland number only five species. Their habitat, mode of growth, and distribution are discussed. Among the points of interest are the following: It has been found that the sponges do not occur in mountain streams, unless there is a lake, however small, in the course of the stream, and that, on the other hand, they occur most luxuriantly in a stream just below its exit from a lake. One species avoids the limestone areas. The variations of the commoner species are traced at some length. The paper is illustrated by numerous drawings of spicules and by maps showing the distribution of the species.—T. A. **Stephenson**: The genus Corallimorphus. Corallimorphus is a genus of deep-sea Actiniaria, first described by Moseley in 1870, and later by Hertwig in 1882 and 1888. There are two specimens of *C. rigidus* in the collection of anemones made by the Fisheries Branch

of the Department of Agriculture and Technical Instruction for Ireland from 1899 to 1913. These specimens are described externally and anatomically in the paper, and compared with the eight other specimens described by Moseley and Hertwig. The possibility of all these specimens belonging to one species is suggested and discussed, with the conclusion that it is quite likely that the genus contains one variable species only. On the other hand, further material is required for a final decision, and if the three species, *C. rigidus*, *profundus*, and *obtectus*, should prove valid, the Irish specimens would probably require a fourth species. It is further pointed out that the thick and rigid body of the anemones in question seems to be correlated with deep-sea life, and that although the genus has sometimes been regarded as a primitive one, it has a number of characteristics which it would seem can be considered only as specialisations or advanced features.

PARIS.

Academy of Sciences, May 25.—M. Henri Deslandres in the chair.—E. **Goursat**: Some transformations of partial differential equations of the second order.—G. **Bigourdan**: The instruments and work of the Sainte-Geneviève Observatory. Historical account of the work of Pingré and of Lechevalier done between 1755 and 1836.—J. **Bossert**: Catalogue of the proper motion of 5671 stars, annotated and published by L. Schulhof.—J. **Baillaud**: The method of the scale of tints in photographic photometry.—C. **Guichard**: Congruences belonging to a linear complex such that the lines of curvature correspond on the two focal surfaces.—G. **Julia**: Families of functions of several variables.—M. **Janet**: Systems of partial differential equations and systems of algebraic forms.—G. **Sagnac**: The real relativity of the energy of the elements of radiation and the motion of waves in the æther.—F. **Vlès**: Ultra-violet spectrophotometry of the nitrophenols. Seventeen nitro-derivatives were examined and the spectra found to be, in general, constituted of three elements: a constant band, due to the NO_2 group; a band related to the presence of the benzene ring; and a third band the origin of which is doubtful.—M. **de Broglie**: The fine structure of X-ray spectra. Details of a doublet given by rhodium, and comparison with the K spectrum of tungsten.—J. L. **Pech**: Phenomena of antagonism between various radiations (ultra-violet, visible spectrum, and infra-red).—L. **Thielemans**: Regulation of cables for the transport of electrical energy to long distances.—P. **Bunet**: The transport of energy to great distances. Remarks on a recent communication by M. Brylinski on the same subject.—M. **Toporescu**: The lime and magnesia carried down by precipitates of ferric oxide. Varying weights of ferric oxide were precipitated in presence of constant quantities of calcium and magnesium salts, and the proportions of lime and magnesia carried down were determined. A second precipitation of the ferric oxide is sufficient to remove calcium salts, but this is not the case with magnesia.—L. **Guillet** and M. **Gasnier**: The plating with nickel of aluminium and its alloys. The aluminium or alloy is cleaned and roughened by sand-blasting, and then takes a satisfactory deposit of nickel. The influence of the size of the sand grains and the time elapsed between the sand-blasting and the deposit have been examined, and results are given.—A. C. **Vournazos**: A new series of complex combinations: the antimony oxyiodides. The mercury compound may be taken as a type of these substances; it has the composition $Hg(SbIO_4)_2$.—R. **Cornubert**: The constitution of some dialkylcyclohexanones. A study of the ketones obtained by treating cyclohexanone with sodium and then with alkyl halides.—C. **Dufraisse**: The stereo-isomeric forms of benzoylphenylacetylene di-iodide. The conditions under which either of the two isomers can be isolated are given.—A. **Mailhe**: The catalytic hydrogenation of the ketazines.—L. **Moret**: The tectonic of the eastern bank of Lake Annecy.—A. **Brives**: Some results of a new journey in Morocco. A completion of geological work commenced in 1919.—P. **Bonnet**: The Permo-Triassic limit in the Himalayan-Armenian geosynclinal.—L. **Dunoyer** and G. **Reboul**: The prediction of the weather.—G. **Truffaut** and H. **Bezssonoff**: The influence of partial sterilisation on the composition of the microbial flora of the soil.—R. **Souèges**: The embryogeny of the Solanaceæ. Development of the embryo in Hyoscyamus and Atropa.—P. **Bertrand**: The constitution of the vascular system in ferns, in Pteridosperms, and in all ancient Phanerogams.—L. **Blaringhem**: The stability and fertility of the hybrid *Geum urbanum* × *G. rivale*. From the morphological point of view the descent of this hybrid is uniform and regularly fertile. Its mixed characters are sufficiently distinct from those of its parents to give a precise diagnosis, and as it propagates without variation in the wild state it can be described as a good systematic species.—J. **Feytaud**: The kings and queens of *Leucotermes lucifugus*.—A. **Mayer**, A. **Guieysse**, and E. **Fauré-Fremiet**: Pulmonary lesions determined by suffocating gases.—A. **Trillat** and M. **Mallein**: The projection of micro-organisms into the air. The influence of humidity.

Books Received.

Calcutta University Commission, 1917-19. Report. Vol. vi. Appendices and Index. Pp. vii+341+plates. (Calcutta: Superintendent, Government Printing, India.) 1 rupee or 1*s*. 6*d*.

A Monograph of the British Orthoptera. By W. J. Lucas. Pp. xii+264+xxv plates. (London: The Ray Society.) 1*l*. 5*s*. net.

The British Charophyta. By J. Groves and Canon G. R. Bullock-Webster. Vol. i. Nitelleæ. Pp. xiv+141+xx plates. (London: The Ray Society.) 1*l*. 5*s*. net.

Ozone. By Prof. E. K. Rideal. Pp. ix+198. (London: Constable and Co., Ltd.) 12*s*. net.

Thomas Henry Huxley. By Dr. L. Huxley. Pp. vii+120. (London: Watts and Co.) 3*s*. 6*d*. net.

Auguste Comte. By F. J. Gould. Pp. v+122. (London: Watts and Co.) 3*s*. 6*d*. net.

Is Spiritualism Based on Fraud? By J. McCabe. Pp. vii+160. (London: Watts and Co.) 3*s*. net.

The Systematic Treatment of Gonorrhœa in the Male. By N. Lumb. Second edition. Pp. viii+123. (London: H. K. Lewis and Co., Ltd.) 5*s*. net.

Optical Projection. By Lewis Wright. Fifth edition. Rewritten and brought up to date by R. S. Wright. In two parts. Part i.: The Projection of Lantern-Slides. Pp. viii+87. (London: Longmans and Co.) 4*s*. 6*d* net.

Diary of Societies.

THURSDAY, JUNE 10.

INSTITUTION OF MINING ENGINEERS (at Geological Society), from 11 a.m. to 5.—(General Meeting.)—Prof. H. Louis: Compensation for Subsidences.—W. Maurice: The Fleissner Singing-flame Lamp.—W. Maurice: The Wolf-Pokorny and Wiede Acetylene Safety-lamps.—G. Oldham: The "Oldham" Cap Type Miner's Electric Safety-lamp.—Discussion on First Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines."—D. S. Newey: A New Method of Working Thick Seams of Coal at Baggeridge Colliery.—T. G. Bocking: Protractors.—T. G. Bocking: Magnetic Meridian Observations; A Method of Utilising the Kew Observatory Records.

ROYAL SOCIETY, at 4.30.—Prof. A. V. Hill and W. Hartree: The Thermo-Elastic Properties of Muscle.—Sir James Dobbie and J. J. Fox: The Absorption of Light by Elements in the State of Vapour: (1) Selenium and

Tellurium; (2) Mercury, Cadmium, Zinc, Phosphorus, Arsenic, Antimony.—Dr. A. E. H. Tutton: Monoclinic Double Selenates of the Copper Group.—H. G. Cannon: Production and Transmission of an Environmental Effect in *Simocephalus vetulus*.—E. C. Grey: The Enzymes of *B. coli communis* which are Concerned in the Decomposition of Glucose and Manitol. Part IV. The Fermentation of Glucose in the Presence of Formic Acid.—L. T. Hogben: Studies on Synapsis. II. Parallel Conjugation and the Prophase Complex in Periplaneta, with Special Reference to the Premeiotic Telophase.

LONDON MATHEMATICAL SOCIETY, at 5.—G. I. Taylor: (1) Tidal Oscillations in Gulfs and Rectangular Basins. (2) Diffusion by Continuous Movements.—H. B. C. Darling: Proofs of certain Identities and Congruences enunciated by Mr. S. Ramanujan.—M. J. M. Hill: The irreducibility of the Solution of an Algebraic Differential Equation.—F. B. Pidduck: Functions of Limiting Matrices.—W. P. Milne: The Relation between Apolarity and a certain Porism of the Cubic Curve.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

CONCRETE INSTITUTE, at 7.30.—E. L. Joseph: Ventilation and Air-Purification as applied to Modern Concrete Buildings.

OPTICAL SOCIETY, at 7.30.—Miss A. B. Dale: Accuracy of Setting.—Dr. J. S. Anderson: A New Method of Immersion Refractometry.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. C. A. F. Benedicks: Recent Progress in Thermo-Electricity (Annual May Lecture).

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JUNE 11.

INSTITUTION OF MINING ENGINEERS (at Geological Society), from 11 a.m. to 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. E. Barnard: Nova Persei No. 2 (Anderson).—A. S. Eddington: Radiation-pressure in Solar Phenomena.—R. A. Sampson: Geophysical Discussions, 1920 May 7: Determination of Longitude by Wireless Telegraphy.—Gén. Ferrié: Note sur les procédés actuels d'emploi de la télégraphie sans fil dans la détermination des Longitudes.—R. A. Fisher: A Mathematical Examination of the Methods of Determining the Accuracy of an Observation by the Mean Error and by the Square Mean Error.—H. S. Plaskett: The Intensity Distribution in the Continuous Spectrum and the Intensity of the Hydrogen Lines in γ Cassiopeiæ.—J. Lunt: The Spectra of Nova Aquilæ No. 3. Third Paper.

PHYSICAL SOCIETY OF LONDON, at 5.—Dr. T. Barratt and A. J. Scott: Radiation and Convection from Heated Surfaces.—J. S. G. Thomas: An Electrical Hot-Wire Inclinometer.—L. F. Richardson: Convective Cooling and the Theory of Dimensions.—J. W. T. Walsh: The Radiation from a Perfectly Diffusing Circular Disc.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

MONDAY, JUNE 14.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Very Rev. Dean Inge: Freedom and Discipline (Annual Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Central House, Finsbury Square), at 5.—(Annual Meeting.)

SOCIETY OF ENGINEERS (at Geological Society), Special Summer Meeting, at 5.30.—E. Cressy: Great Engineering Adventures.

FARADAY SOCIETY (at Chemical Society), at 8.—Dr. A. Fleck and T. Wallace: Conduction of Electricity through Fused Sodium Hydrate.—Dr. H. F. Haworth: The Measurement of Electrolytic Resistance using Alternating Currents.—J. L. Haughton: The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures.—N. V. S. Knibbs and H. Palfreeman: The Theory of Electrochemical Chlorate and Perchlorate Formation.—J. B. Firth: The Sorption of Iodine by Carbon.—F. H. Jeffery: The Electrolysis of Solutions of Sodium Nitrate using a Copper Anode.—Dr. A. M. Williams: The Pressure Variation of the Equilibrium Constant in Dilute Solution.—Miss Nina Hosali: Description of Models illustrating Crystalline Form and Symmetry.

TUESDAY, JUNE 15.

ROYAL HORTICULTURAL SOCIETY, at 3.—Dr. A. B. Rendle: Plants of Interest in the Day's Exhibition.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

ROYAL STATISTICAL SOCIETY, at 5.15.—G. F. Shirras: Some Effects of the War on Gold and Silver.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—W. A. Richardson: The Fibrous Gypsum of Nottinghamshire.—F. P. Mennell: Rare Zinc-Copper Minerals from the Rhodesian Broken Hill Mine, Northern Rhodesia.—Prof. R. Ohashi: The Plumbiferous Barytes from Shibukuro, Prefecture of Akita, Japan.—W. A. Richardson: A New Model Rotating Stage Petrological Microscope.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions to the Society's Menagerie during the Month of May, 1920.—Prof. J. E. Duerden: Exhibition of, and Remark on, Ostrich Eggs.—Miss Joan B. Procter: (1) A Collection of Tailless Batrachians from East Africa made by Mr. A. Loveridge in the Years 1914–19. (2) The Type-specimen of *Rana holsti*, Boulenger.—R. I. Pocock: The External and Cranial Characters of the European Badger (Meles) and the American Badger (Taxidea).—Dr. R. J. Tillyard: The Life-history of the Dragon-fly.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. F. G. Parsons: Distribution of Hair and Eye Colour in the British Isles.

WEDNESDAY, JUNE 16.

ROYAL METEOROLOGICAL SOCIETY (at the Royal Astronomical Society), at 5.—W. H. Dines: The Ether Differential Radiometer.—Prof. S. Chapman and E. A. Milne: The Composition, Ionisation, and Viscosity of the Atmosphere at Great Heights.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Mechanical Engineers), at 6.—Discussion on paper read by Sir Dugald Clerk before the Royal Society of Arts, entitled Distribution of Heat, Light, and Motive Power by Gas and Electricity.—Sir Dugald Clerk, Prof. A. Smithells, and Prof. J. W. Cobb: The Report on the Coal-Gas and Electrical Supply Industries of the United Kingdom to the President of the Institution of Gas Engineers.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Sir Horace Darwin and W. G. Collins: A Universal Microtome.—L. Hogben: The Problem of Synapsis.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.—Prof. W. Bateson: Genetic Segregation (Croonian Lecture).

LINNEAN SOCIETY, at 5.—Celebration of the Centenary of Sir Joseph Banks, Bart. (1743–1820).—Dr. B. Daydon Jackson: Banks as a Traveller.—Dr. A. B. Rendle: Banks as a Patron of Science.—J. Britten: Banks as a Botanist.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. C. McLennan: Helium.

FRIDAY, JUNE 18.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Valentine Chirol: The Enduring Power of Hinduism (Sir George Birdwood Memorial Lecture).

GEOPHYSICAL COMMITTEE (at Royal Astronomical Society), at 5.—Commander H. D. Warburg, Prof. H. Lamb, Dr. J. Proudman, Prof. A. F. Dodson, Major A. J. Wolff, and H. L. P. Jolly: Discussion on Tides.

SATURDAY, JUNE 19.

BRITISH PSYCHOLOGICAL SOCIETY (at University College, Gower Street), at 3.30.—Dr. J. Drever: The Emotional Phases of Affective Experience.

PHYSIOLOGICAL SOCIETY (at Physiological Laboratory, University of London, South Kensington), at 4.30.—G. Aurep and C. Lovatt Evans: The Mode of Action of Vaso-dilator Nerves.—C. Lovatt Evans: The Lactic Acid Content of Plain Muscle.

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